modern castings

and American Foundryman

AUGUST, 1955

Owned by THE MEN WHO BUY

Molds out of Glass

Almost pure crushed silica glass helps make smoother castings in new process

A Sweet Core Binder

Ammonium sulphate catalyzes corn sugar under heat to form strong core resin

Success in Ni-Al Bronze

Here's research report on the first big nickel-aluminum bronze ship propeller

The Case of The Absorbed Oxygen

Gray iron castings have more oxygen than expected. They actually "breathe" it in

Let's Make Basic Steel

But before we do let's be patient and get ready for some headaches

No Chain Failures Here

Unusual system of inspection, maintenance and procurement eliminates foundry trouble

BONUS SECTION

16-page special report on Molding Materials, Methods and Machines.

future meetings and exhibits

SEPTEMBER

1-15 . . Engineering, Marine and Welding Exhibitjon and Foundry Trades Exhibition, *Olympia, London, England.*

6-17 . . National Machine Tool Builders Association, *International Amphitheater, Chicago. Machine Tool Show.*

6-17 . . Coliseum Machinery Show, *Chicago Coliseum, Chicago.*

6-17 . . Production Engineering Show, *Navy Pier, Chicago.*

12-16 . . Industrial Engineering Conference, *Michigan State University, East Lansing, Mich.*

12-16 . . Instrument Society of America, *Shrine Exposition Hall, Los Angeles. 10th Annual Conference and Exhibit.*

20-22 . . Tenth Annual Industrial Packaging & Materials Handling Exposition, *Kingsbridge Armory, New York. Sponsored by Society of Industrial Packaging & Materials Handling Engineers.*

29-30 . . Missouri Valley Regional Conference, *Missouri School of Mines, Rolla. Sponsored by the St. Louis, Mo-Kan and Tri-State Chapters of AFS, in cooperation with Missouri School of Mines.*

OCTOBER

6-7 . . National Foundry Association, *Edgewater Beach Hotel, Chicago. Fifty-seventh Annual Meeting.*

13-15 . . Foundry Equipment Manufacturers Association, *The Greenbrier, White Sulphur Springs, W. Va. Annual Meeting.*

13-15 . . Committee on Vacuum Techniques Inc., *Mellon Institute, Pittsburgh. Symposium on vacuum technology.*

14-16 . . Northwest Regional Foundry Conference, *Portland, Ore.*

16-18 . . Conveyor Equipment Manufacturers Association, *The Greenbrier, White Sulphur Springs, W. Va. Annual Meeting.*

17-18 . . American Coke and Coal

Chemicals Institute, *The Greenbrier, White Sulphur Springs, W. Va. Annual Meeting.*

17-21 . . National Safety Congress and Exposition. *Chicago, Ill. Forty-third Annual Congress*

17-21 . . American Society for Metals, *Convention Hall, Philadelphia. National Exposition and Congress.*

18 . . American Society of Safety Engineers, *Conrad Hilton Hotel, Chicago. Annual Meeting.*

19-21 . . Gray Iron Founders' Society, *Hotel Schroeder, Milwaukee. Twenty-seventh Annual Meeting.*

20-21 . . Ohio Regional Foundry Conference, *Case Institute of Technology, Cleveland. Sponsored by the Northeastern Ohio, Toledo, Canton District, Central Ohio, and Cincinnati District Chapters of AFS in cooperation with Case Institute of Technology.*

20-21 . . Sixth Annual National Noise Abatement Symposium, *Armour Research Foundation of Illinois Institute of Technology, Chicago.*

24-25 . . Steel Founders' Society of America, *The Greenbrier, White Sulphur Springs, West Virginia. Fall Meeting.*

31-Nov. 1 . . Magnesium Association, *Biltmore Hotel, New York. Annual Meeting.*

NOVEMBER

1-3 . . Grinding Wheel Institute and Abrasive Grain Association, *Statler Hotel, Buffalo. Fall Meeting.*

1-3 . . Investment Casting Institute, *Sheraton-Cadillac Hotel, Detroit. Annual Fall Meeting.*

3-4 . . Metals Casting Conference, *Purdue University, West Lafayette, Ind. Sponsored by the Central Indiana and Michiana Chapter of AFS in cooperation with Purdue University.*

14-17 . . International Automation Exposition, *Navy Pier, Chicago.*

16-18 . . Steel Founders' Society, *Hotel Carter, Cleveland. Annual Technical and Operating Conference.*

17-18 . . American Society for Quality Control, *Schroeder Hotel, Milwaukee. Tenth Mid-West Conference.*

DECEMBER

1-2 . . Michigan Regional Foundry Con-

FOR MORE FACTS, CIRCLE No. 51 P. 81-82

ference, *Michigan State College, East Lansing, Mich.*

7-9 . . American Institute of Mining and Metallurgical Engineers, *Hotel William Penn, Pittsburgh. Electric Furnace Steel Conference.*

1956
FEBRUARY

9-10 . . Wisconsin Regional Foundry Conference, *Schroeder Hotel, Milwaukee. Sponsored by the AFS Wisconsin Chapter and the University of Wisconsin and the AFS Wisconsin Student Chapter.*

16-17 . . Southeastern Regional Foundry Conference, *Tutwiler Hotel, Birmingham, Ala. Sponsored by the Birmingham District and Tennessee Chapters and the University of Alabama Student Chapter of American Foundrymen's Society.*

27-Mar. 2 . . American Society for Testing Materials, *Statler Hotel, Buffalo. 1956 Committee Week.*

MARCH

7-8 . . Foundry Educational Foundation, *Hotel Cleveland, Cleveland. College-Industry Conference.*

15-16 . . Steel Founders' Society of America, *Drake Hotel, Chicago. Annual Meeting.*

MAY

3-9 . . American Foundrymen's Society, *Convention Hall, Atlantic City, N. J. 60th Annual Convention and Exhibit.*

CO_2 Process Filmed

Carbon Dioxide Process for molds and cores in a production foundry is portrayed in a new 600-ft. 16mm black and white, silent motion picture available from the American Foundrymen's Society.

The only picture of its type in existence, the film shows the application of sand with sodium silicate binders to a variety of jobs.

Based on Dr. Waldemar Schumacher's work in Germany, it runs approximately 20 min. and has been provided with English captions. The film may be obtained through the American Foundrymen's Society, Golf & Wolf Rds., Des Plaines, Ill., at $10 a showing. Interested parties are requested to specify alternate dates for the running of the film because of the heavy demand.

BONUS SECTION

august 1955

vol. 28 no. 2

modern castings

and American Foundryman

in this issue

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TIPS, TRENDS AND TECHNIQUES

By far the greatest tonnage of castings is produced in green sand. The bench molder on the cover illustrates the most flexible molding method and the most economical for extremely short runs or one-off jobs. But he's one stage removed from the molder of many years ago. He's supplementing the "armstrong" method of ramming with an air rammer, a fundamental step toward mechanization and higher production. This month's bonus section covers this and other steps toward utilization of molding materials, methods, and machines.

First one-piece nickel-aluminum bronze propellor of seagoing size and how the material for it was selected makes foundry history. **Modern Castings** brings it to you in the lead story on page 24.

Too new to be included in the bonus section is the mold making process using powdered glass in the form of a slip (idea borrowed from ceramicists) for production of precision castings. See page 30.

Basic steel is getting more and more attention and deservedly so. But melting problems aren't the same as in acid furnaces. The author says (page 33) "OK, let's make basic steel, but let's be aware of the problems we're tackling."

Corn sugar, like molasses, has its drawbacks as a core binder. But when you throw some ammonium sulphate into the core mix along with the sugar it's a different story. See page 55.

For many years the high oxygen content of cast iron has mystified metallurgists who couldn't understand how so much oxygen could be retained by a metal with so many reducing constituents in it. Solution to the mystery is on page 58.

Chains and slings need not fail in service and won't if procedures described on page 62 are followed.

How about September? Current accurate cost information on your operations is the only way to keep up with today's highly competitive market. How to control foundry costs is detailed in next month's Bonus Section . . . Regular articles will deal with risering . . . core room pitfalls . . . pressure casting of steel in graphite molds . . . evaluation of forehearth refractories for desulphurizing . . . and others.

pouring off the heat

vibrator shakes 'em up

■ PLEASE MAIL COPY ANY ADDITIONAL DATA AVAILABLE AND ADVISE NAME AND ADDRESS SUPPLIER VIBRATOR. DEVICE MENTIONED PAGE 43 JUNE ISSUE.

S. F. SWAIN, *Asst. Sec. & Treas.*
Golden Foundry Co.
Columbus, Ind.

■ In Talk of the Industry, June issue, you told of a new type vibrator which gives 40 times the energy at only 1/20 the air consumption when operated at usual plant pressures. Where can I get more information about this "thing"?

PAUL W. WAGNER, *Res. & Dev. Mgr.*
Morris Bean & Co.
Yellow Springs, Ohio

■ In Talk of the Industry you mention a vibrator that gives 40 times the energy and makes very little noise. I'm interested in this for our core room.

HENRY G. STENBERG, *Fdry. Supt.*
Draper Corp.
Hopedale, Mass.

■ Tell me the name and address of the manufacturer or ask them to have a representative call on me as I need a source of vibration such as you describe in Talk of the Industry.

JOHN L. SCHMIEDER, JR.
Research Engineer
Oberdorfer, Foundries, Inc.
Syracuse, N.Y.

Contact Russel C. Kinsman, Vice-President, Branford Co., 131 Chestnut St., New Haven, Conn.—Editor.

steel report is hot issue

■ In the May issue it is mentioned in Talk of the Industry that the Steel Research Committee of the American Foundrymen's Society had recently published a report on hot tearing of steel castings. We

would very much appreciate if you could provide us with a copy of this report.

MORRIS ITZEL, *Res. Met.*
SKF
Katrineholm, Sweden

■ If available, the writer would appreciate receiving a copy of the Steel Research Committee's report on hot tearing mentioned in Talk of the Industry.

G. W. HECK, JR., *Chf. Met.*
Birdsboro Steel Foundry & Machine Co.
Birdsboro, Pa.

■ Please send a copy of the hot tearing research paper reported in Talk of the Industry.

ROBERT A. EIDAM, *Spcl. Appr.*
Continental Foundry & Machine Co.
East Chicago, Ind.

The AFS report on hot tearing of steel castings has not been published, but a condensation is scheduled for an early issue of *Modern Castings*. Conclusions taken from the 80 pages of data and discussion are:

1. Core hardness seems to exert the strongest influence of any individual factor.

2. Next most apparent effect is due to the type of deoxidation practice—non-aluminum vs. aluminum oxidation giving somewhat better results.

3. Varations in chemistry within the Grade B specification and within the limits of the study do not appear to effect hot tearing noticeably.

4. There is no correlation between pouring temperature and tearing.

5. There is no relationship of pouring rate to tearing.

6. The as - cast microstructure sampled 180° from the gate bears no relationship to tearing.

7. No structure pattern in the torn area could be defined as being influential.

8. Within the scope of the study, the inclusion count using the work of Simms as a standard, does not give conclusive information.

9. No correlation of the number and types of inclusions to tearing tendencies could be found using ASTM standards.

The study was conducted by the

AFS Steel Research Committee working with eight steel foundries and Armour Research Foundation. The foundries, representing every type of steel melting practice, poured cylindrical test castings under controlled conditions using cores of specified hardnesses made from standard mixtures.—Editor.

to see coke in action

■ Where can we see the operation using high-density coke mentioned in Talk of the Industry, June issue?

HENRI LOUETTE, *Gen. Supt.*
Warden King Ltd.
Montreal, Que.

A. S. Klopf, General Sales Manager, Missouri Coke & Chemical Div., Great Lakes Carbon Corp., 3570 Lindell Blvd., St. Louis 3, Mo., can help you.—Editor.

develops aircraft castings

■ We have noted with interest the item appearing in Talk of the Industry in May referring to hollow or box construction. Can you give us the address of the foundry concerned?

E. A. WOODWARD, *Librarian*
Hadfields Ltd.
Sheffield, England

Write to H. H. Harris, Director, Castings Potentials Project, Alloy Engineering & Casting Co., Champaign, Ill.—Editor.

tear sheets gladly sent

■ It is possible to obtain two sets of tear sheets on the article starting on page 90 of the June issue, *"Start Duplex Malleable Controls with Raw Material"* by L. E. Emery?

D. TAMOR, *Chf. Met.*
American Chain & Cable Co.
Reading, Pa.

■ I would appreciate receiving a reprint of *"Titanium Casting Metallurgy and Production Techniques"* by D. I. Sinizer and C. M. Adams, Jr., which appeared in the June issue.

R. F. MALONE, *Res. Met.*
Rem-Cru Titanium, Inc.
Midland, Pa.

■ Please send six tear sheets of the Foundry Facts article on horizontal

gating systems by John G. Kura from the May issue.

R. F. MEADER, *Fdry. Supt.*
Whitin Machine Works
Whitinsville, Mass.

■ One of our engineers is interested in *"Foundry Noise and Its Control"* by H. T. Walworth published in May.

C. S. IDEN, *Librarian*
International Harvester Co.
Chicago

■ We would like a few copies of *"Five Ways to Desulphurize"* by D. E. Parsons and S. L. Gertsman which you ran in June.

KATHLEEN T. GARNER,, *Res. Lib.*
Diamond Alkali Co.
Cleveland

■ We would like to secure tear sheets of the article *"Casting Steel Pots"* which T. R. Stanley wrote for the February issue of AMERICAN FOUNDRYMAN.

W. J. JENNI, *Prod. Manager*
Morris P. Kirk & Son, Inc.
Los Angeles

Issue Thermocouple Data

"Reference Tables for Thermocouples," Circular 561, has just been issued by the National Bureau of Standards. Superseding Circular 508, this volume gives expanded reference tables for platinum-platinum-10-per cent rhodium, platinum-platinum-13-per cent rhodium, chromel-alumel, iron-constantan (modified 1913), copper-constantan, and chromel-constantan thermocouples with temperature in degrees Celsius (centigrade) and Fahrenheit and electromotive force in millivolts as the arguments. The tables are based upon the absolute electrical units and the International Temperature Scale of 1948.

Costs 50¢ a Copy

Copies may be obtained by writing National Bureau of Standards, Government Printing Office, Washington 25, D.C., at 50c a copy. Foreign remittances must be in U. S. exchange and should include an additional one-third of the publication price to cover mailing costs.

products and processes

Metal Repair Compound

Metalset A201 is epoxy resin compounded with aluminum and other ingredients to form a thixotopic paste, ideal for building up or filling metal surfaces. Machines to a high luster and to a feather edge; can be drilled and tapped. Is particularly useful for thick applications since it has good dimensional stability. There is no solvent in A201, hence no evaporation to cause shrinkage and cracking. Curing is result of polymerization. *Smooth-On Mfg. Co.*

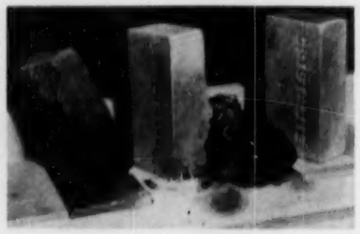
FOR MORE FACTS, CIRCLE No. 1 P. 81-82

X-Weld Chain

Four-leg cling of 3/4-in. x-weld chain handles this 35,000-lb casting safely and efficiently. The exposed lugs in each link prevent kinking and bending, and provide a joint that is stronger than the link itself. There is very little denting or burring from rough castings. X-weld chain of type 321

stainless steel will not scale until 1500 F is approached; a super stainless steel chain withstands 1800 F. Both stand up under acids normally used in pickling. Chain sizes range from 1/4-in. to 3/4-in. with working load limits from 3250 to 23,000 lb. *American Chain Cable Co., Inc.*

FOR MORE FACTS, CIRCLE No. 2 P. 81-82



Synthetic Mullite Refractory

Crystalite bricks are superior to two competing brands of premium mullite refractories when heated to 3330 F and held for 4 hr. Preliminary installations of this new refractory show improvements in operating life as high as 250 per cent. Several grades of Crystalite, an improved synthetic mullite refractory, available in the form of bricks, special shapes, and ramming mixes, are described in Bulletin CR-11. *Richard C. Remmey Son Co.*

FOR MORE FACTS, CIRCLE No. 3 P. 81-82

Sound Analyzer

With industry becoming more alert to the necessity for sound control, both in its products and in its plants, sound measurement and analysis have been simplified by the recently developed Third Octave Spectrum Analyzer Model B L-2109. The instrument, through the use of a narrow frequency band analysis, provides physical measurement data that is easily correlated to subjective tests for loudness of sound or the intensity of vibration. Unit works in the range of frequencies from 35 to 19,000 cycles per second. *Brush Electronics Co.*

FOR MORE FACTS, CIRCLE No. 4. P. 81-82

Furnace Atmoshere Controller

Carbotrol, new, dew point controller, automatically controls carbon potential of furnace atmospheres produced by endothermic gas cracking generators. Heat treater merely sets instrument for carbon content of metal being treated and Carbotrol keeps protective atmosphere in equilibrium with metal. Automatic adjustment of generator takes care of varying analyses of raw gas supply. Operating on 115 v, and 20-150 lb air, the instrument controls carbon potential to 0.30 to 1.5 per cent carbon and the dew point from +70 F to −5 F. *Lindberg Engineering Co.*

FOR MORE FACTS, CIRCLE No. 5 P. 81-82

Fast Sketching Method

Sketch-Easy is a time-saving drawing method adapted to in-plant training. A few hours with a kit enables persons with no previous drawing experience to lay out three dimensional idea and shop fabrication sketches in one-third the time normally taken by conventional methods. *Technical Service Div., Northrop Aeronautical Institute, Inc.*

FOR MORE FACTS, CIRCLE No. 6 P. 81-82

Shell Core Blower

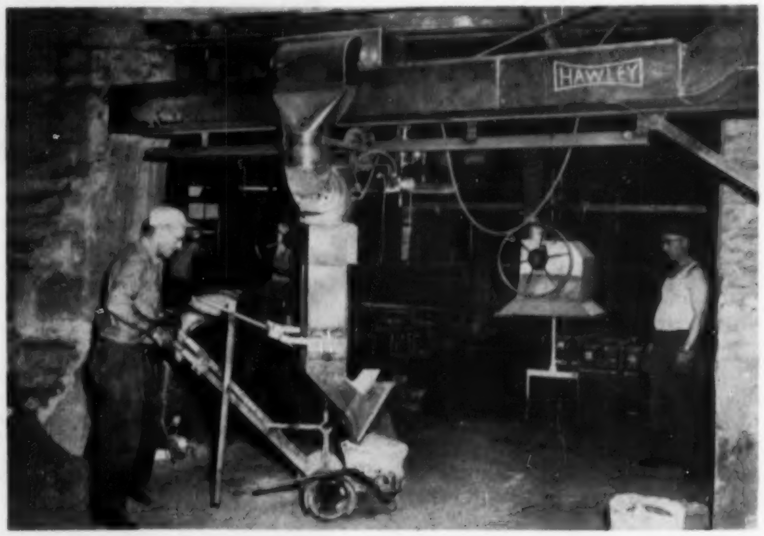
Model SCB-2 produces 10-lb cores easily in core boxes up to 9-3/4 x 6 x 11-in. in size, at up to 120 cycles per hour. Only air pressure and gas for the curing oven are needed. Designed for two core boxes, one can be used with no complications. One shell core is curing while operator removes cores, and blows and drains core box at other station. Different cores can be made at the same time if box measurements are similar. *Shell Process, Inc.*

FOR MORE FACTS, CIRCLE No. 7 P. 81-82

Dust-Tight Solenoid Valves

Manufacturer of Quick-As-Wink air and hydraulic control valves, has improved its O-type solenoid valves by changes that are said to effectively protect all operating parts from the entrance of dust and grit. A sintered bronze filter is now provided in the breather hole of the spring cap. This permits air to pass through the filter in

Mobile Fume Control System



Hawley Fume Control System for collecting toxic and non-toxic fumes at their source consists of a sheet metal hood suspended from a non-inflamable flexible duct, directly above the ladle or crucible throughout pouring, above other processes giving off fumes. The flexible duct is suspended from a mobile transition box which runs on a track mounted on top of an exhaust duct. Fumes enter the exhaust duct at whatever point the mobile transition box happens to be. The system can be integrated readily with mechanical pouring equipment. The Hawley System is said to greatly reduce health hazard and to reduce plant heat loss since it operates with only 2500 cfm. Described in illustrated Bulletin 555. Martin Equipment Co.

FOR MORE FACTS, CIRCLE No. 8 P. 81-82

either direction, but prevents the entrance of dust or grit. A sleeve, sealed with "O" rings at two places, prevents dust from entering the area where the solenoid armature contacts the valve plunger. The top half of the newly designed two-piece cover fits tightly over the bottom half of the covers protecting the solenoid from dust, oil, grit and foreign particles, even those blown around during cleaning up operations. *C. B. Hunt & Sons, Inc.*

FOR MORE FACTS, CIRCLE No. 9 P. 81-82

Flexible Shaft Machine

Model M50 multi-speed, low pedestal-type flexible shaft machine was found by one foundry to be the best way to remove fins from the inside of small diameter cast iron fittings. Operator experienced almost no fatigue, with a 2½-in. wheel at 3450 rpm with this

¾ hp machine. Can also operate at 1150, 2100, and 5750 rpm by easily changing an eccentric countershaft; motors may also be 1, 1½, 2, or 3 hp. Belt and pulleys completely guarded. The 6-ft flexible shaft can handle grinding and buffing wheels, sanding discs and drums, wire brushes, and drills. *Stow Manufacturing Co.*

FOR MORE FACTS, CIRCLE No. 10 P. 81-82

Quality Control Slide Rule

Qualitrule, new circular slide rule, is an aid in applied statistics, particularly industrial quality control. It presents, in one setting, the upper (2-200 units) and lower (0-50 units) limits for the number of defectives to be expected in a sample size from 2 to 1000, provided the sample is taken at random from a much larger "population" having a certain over-all average per

cent defective (0.5-20 per cent). All figures are read directly without intermediate computation. Numerical relations are based on rigorous probability equations rather than on several approximation formulas now widely used. All scales in contrasting colors appear on one side of the 7-in. diam plastic computer. *American Hydromath Corp.*

FOR MORE FACTS, CIRCLE No. 11 P. 81-82

Packaged Dust Collector

Centri-Merge packaged dust collector unit, designed especially for pouring and shakeout stations, has a built-in reservoir that permits re-cycling water, minimizing make-up water. The fresh water fill manifold is equipped

with a solenoid valve to insure economic operation at maximum efficiency. Attached adjustable hood (readily removed for cleaning) collects hazardous fumes and dust without interfering with overhead crane. *Schmieg Industries, Inc.*

FOR MORE FACTS, CIRCLE No. 12 P. 81-82

Portable Potentiometer

The Wheelco Portable Potentiometer is capable of providing extreme accuracy in checking installations of temperature measurement and control instruments, both in the laboratory and shop. Unit is readable to 0.025 millovolts and the scale length exceeds 40 in. Models are available with a built-in run-up box and calibrated rheostat for line resistance compensation. A built-in thermometer is also available for cold junction temperatures. Net weight is approximately 10 lb. Bulletin F 5760-1, available *Barber Colman Co., Wheelco Instruments Div.*

FOR MORE FACTS, CIRCLE No. 13 P. 81-82

Horizontal Vibrating Screen

Straightline Vibrating Screen is especially suited for de-watering high capacity loads and sizing of material where headroom is limited. One vibrator is mounted on each side of screen at deck level for ease of inspec-

tion. Both are located at the center of gravity, to assure uniform vibration; they do not project above the sideplates. Straightline screens are available in sizes from 4 by 8 ft to 6 by 20 ft with one or two decks. Complete line on Data Sheet 2562. *Link-Belt Co.*

FOR MORE FACTS, CIRCLE No. 14 P. 81-82

pH Meter

Line-operated pH Meter Model 110 incorporates large-size indicating meter of 7-in. scale covering entire pH range from 0 to 14 without switching and without reversal of pointer travel.

Intended mainly for laboratory use but can be furnished portable with baseboard and carrying cover. Can be used on any voltage from 80 to 260; 40/60 cycles AC. Accuracy is 0.02 pH unit. Bulletin 105 available. *Photovolt Corp.*

FOR MORE FACTS, CIRCLE No. 15 P. 81-82

Ultrasonic Metal Cleaner

Bendix Ultrasonic Cleaner cleans dust, insoluble solids, oxidation, abrasives, etc., from metal parts by directing high-frequency sound waves through water-soluble detergents or other solvents surrounding the parts to be cleaned. The energy of "silent sound" scrubs microscopically by forcing the

cleaning solution to cavitate or "c
boil"; ultrasonic energy bomba
parts from every direction, penetrat
interstices and crevices, scouring
blind holes and the like. Minute
plosions caused by the cavitation
tually blast loose contamination. B
chure describes techniques and cle
ing service laboratory. *Pioneer-Cen
Div., Bendix Aviation Corp.*

FOR MORE FACTS, CIRCLE No. 16 P. 81

4-Wheel Drive Tractor Shovel

Model HO four-wheel-drive Payloa
tractor-shovel has a capacity of 2
yd. It is similar in styling and c
ward appearance to the 1 and 1½
yd models HU and HH recently

troduced. Outstanding features
clude new standards of safety and s
bility. Also new is complete pow
shift transmission that eliminates sto
or slowing down for shifting in eith
forward or reverse. *Frank G. Hou
Co.*

FOR MORE FACTS, CIRCLE No. 17 P. 81

Crane Runway Control

Developed primarily as a safety devi
a new control system for crane runwa
permits workers to attend to a disabl
crane without danger from oth
cranes approaching on the same ru
way. System automatically gives war
ing of the approach or shuts off t
movement of an oncoming crane. D
tance at which the warning or shut-
action is effective is adjustable fro
one to twenty ft with the proper s
ting made at time of installation. A
ditional literature is available. *Fema
Inc.*

FOR MORE FACTS, CIRCLE No. 18P. 81-

Fool-Proof Arc Time Totalizer

Arc Time Totalizer registers time
arc-current is in use and operates wi
an accuracy never before attained d
to simple, no-moving-parts constru
tion. A particular advantage is th

Continued on page 15

FOR MORE FACTS, CIRCLE No. 60 P. 81-

talk of the industry

SKILLED, ADEQUATE, VERSATILE work force for all industry is the goal of the U.S. Bureau of Apprenticeship we were told at the first meeting of its kind in Washington, D.C., July 20. Castings industry was selected for this first meeting on manpower because its products are basic to all other industries. Basis for a survey was developed to determine what skills foundries want in their workers, how many workers they need, and what training techniques have been most effective.

CO_2-WATER GLASS-bonded cores work fine in permanent molds, Walter Klayer, works manager, Aluminum Industries, Inc., reports. A 7-lb. aluminum automotive casting formerly made with a ½-lb conventional core had to be vented carefully to avoid core blows. Now the cores are blown, given a 4 or 5-sec shot of CO_2 while still in the box (eliminates driers), then are ready for immediate use in the permanent mold.

HOW MUCH WILL YOU SAVE, we asked several foundrymen at a recent meeting, if you reduce your scrap loss 1 per cent? $90,000 a year a representative of a large malleable foundry said. Reducing scrap in a gray iron foundry from 12 to 9 per cent made the difference between a $12,000 loss and a $30,000 profit, a consultant reported. Anyone doubt that a scrap reduction program is valuable from a dollar standpoint as well as the public relations advantage of casting dependability?

NATIONAL CASTINGS COUNCIL elections at the group's annual meeting July 15 put Wm. L. Leopold, Northern Bronze Corp., in the president's chair. He is also president of the Non-Ferrous Founders' Society. New NCC vice-president is Bruce L. Simpson, National Engineering Co., president of the American Foundrymen's Society.

WATER HAS SUBSTITUTED for molten metal in gating studies sponsored by the American Foundrymen's Society. Some researchers in fluidity have even run supersaturated solutions through refrigerated glass tubes to try to duplicate the effect of solidification on flow. But Cal Chambers, president of Texas Foundries, is believed to be one of the few (maybe the only one) who has used water to train pourers. Here's how it happened. When the foundry was started in Lufkin less than two decades ago, skilled foundry workers didn't exist in the area. Molten metal, sparks, and fumes disturbed the green workers so much they dropped their ladles and the few experienced hands, including Col. Chambers, finished off the first heat. The rest of the week, pourers-to-be practiced catching, carrying, and pouring steaming hot water as it came out of a hose at the taphole--simulating virtually everything but the sparks.

SHORT CUTS and design simplifications that save thousands of dollars come up when engineers ask patternmakers and shop supervisors for ideas. Yet, writes H. E. Grant, professor of engineering drawing, Washington University, in "Reducing Costs in the Drafting Room" (Product Engineering, June 1955) he is amazed to learn from many plants he has visited that neither head patternmaker nor the shop supervisors were consulted on new designs developed in the

engineering department. It's an old story to foundrymen who are now beating designers at their own game by catching designs at the drawing board stage and showing how castings can do the job better. Or they redesign non-cast parts already in production so they can be made as castings. Sells a lot of castings, creates new foundry business, and teaches designers to think of castings more often in the future.

PROTECTIVE COATING for magnesium alloys developed by the National Bureau of Standards is potentially more economical than other anodizing processes used while providing equivalent protection against salt-spray corrosion. Using low-voltage (10-12 v) alternating instead of direct current, the new process causes a coating to form on both electrodes. Bath contains, besides water, only sodium or potassium hydroxide and the corresponding chromate. Current of 80 to 140 amp/sqft through bath for 20-40 minutes, at 150-170 F, forms coating 1-2 mils thick. Coating is smooth and gray-green but not as uniform in appearance as the HAE or acid chromate coatings. If anodized panels are bent or flexed, coating cracks on tension side, chips or shatters on compression side.

COSTS YOU VERY LITTLE but it's worth a great deal to the industry--the safety, hygiene, and air pollution control program the American Foundrymen's Society carries on for the castings industry, that is. Ken Smith, Caterpillar Tractor Co., Peoria, Ill., vice-chairman of the committee directing the work, estimates that the value of travel cost and salaries of committee members exceeds $1000 per meeting. Participating foundries and equipment manufacturers are investing over $20,000 annually on committee meetings alone to make the foundry a better place in which to work.

FOUNDRY FACILITY SURVEY in which the Copper Div. of BDSA is surveying brass and bronze foundries will determine, according to Wm. A. Meissner, Jr., deputy director of the division, what facilities are available for production of military, AEC, and other rated orders. May assist in placing contracts in event of all-out mobilization too. Other uses of the information: tax amortization cases and government loans. Information being requested includes type of castings which may be produced, production capacity, location of facility, and type of materials consumed.

IRON WHISKERS with measured tensile strengths approaching the predicted theoretical value of 1,000,000 psi have been produced by Westinghouse researchers. They're making pure, perfect crystals up to 2 in. long and 0.001 in. thick by treating highly purified $FeCl_3$ with hydrogen at 1100 F. HCl forms and the billions of unattached iron atoms migrate together to form perfectly square (cross section) long slivers. In the absence of sufficient pure iron slivers, and an economical way to convert them to castings, ferrous foundrymen will probably continue to produce "impure" iron castings in which desired properties are achieved by alloying and heat treating.

SALES AND NEW ORDERS have been generally upward since the last quarter of 1954. Rate at which new orders were coming in turned down after May 1953 and sales reached their peak in July of that year, the National Association of Manufacturers points out. In the ensuing period new orders were behind current sales as industry lived off an accumulation of orders piled up in the past. After January 1954 new orders turned up while sales continued downward to a low in October 1954. Since then both sales and new orders have been generally upward with new orders providing a stimulus to future activity by exceeding the volume of current sales.

Herbert F. Scobie

continued from page 12
current leakage, or any current below a specified amount, will not register on the clock. Completely free of maintenance once installed. Model 146 totalizes only the time an arc current is in use; Model 150, in addition, totalizes the time the welding generator is in operation. *Exline Engineering Co.*

FOR MORE FACTS, CIRCLE No. 19 P. 81-82

Positive-Rake Band Saw Blades

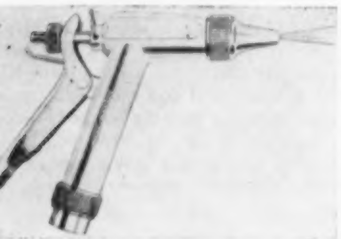
Lenox Hook-Tooth band saw blade with positive rake teeth is recommended for cutting non-ferrous metals, wood, and plastics. Forward inclined teeth "hook" into the work to cut with greater ease and at higher feeds than

conventional zero-rake teeth. The new blade also features rounded gullets for maximum chip clearance. Teeth are flame-hardened to 3-65 Rockwell C; blade back is 25-30 Rockwell C. Blades are available in ½ to 1 in. widths, from 2 to 6 teeth per in., in 100-, 250-, and 500-ft coils or cut to length and welded. *American Saw & Mfg. Co.*

FOR MORE FACTS, CIRCLE No. 20 P. 81-82

Positive Control Air Blow Gun

Pistol-grip, positive-control mechanism in the Gilmour Hosemaster No. 482 air blow gun offers a continuous scale, wide-range flexibility of force from gen-



tle zephyr to raging torrent of air. Exclusive ring lock at rear of nozzle permits holding any air pressure indefinitely. *Gilmour Manufacturing Co.*

FOR MORE FACTS, CIRCLE No. 21 P. 81-82

FOR MORE FACTS, CIRCLE No. 61 P. 81-82

for the asking

Non-Ferrous Furnaces

Bulletin 104 says there is a Hausfeld furnace for every non-ferrous melting problem. Styles 180-GT to 693-GT take crucibles from No. 40 to No. 10,000 with red brass capacities of 120 to 3000 lb. Drawings and dimensions are given. Flexibility is built in with improvements such as roller bearings, adjustable swing top arrangement, refractory-lined slag hole door and frame, and improved burner. Furnace construction, fuel types, and fuel consumption are discussed. *Campbell-Hausfeld Co.*

For more facts, circle No. 22 p. 81-82

V-Belt Catalog

Complete line of Maurey Mor-Grip fractional horsepower and heavy duty multiple V-drive belts is described in new 24-page catalog. Multiple line consists of super, steel cable, open end, and hexagon V-belts as well as V-link belting. Construction and applications of each type of V-belt is described. *Maurey Mfg. Corp.*

For more facts, circle No. 23 p. 81-82

Hydro-Finish

Hydro-Finish is a modified form of impact blasting using an abrasive suspended in a liquid which is delivered to the blasting nozzle by either suction or circulating pump. There is no limit to the fineness of the particle which may be used, therefore no limit to the fineness of finish obtained. Description of this operation and of four blast cabinets and their specifications are given in Bulletin 1403. *Pangborn Corp.*

For more facts, circle No. 24 p. 81-82

Pan Conveyors

Bulletin 3255 explains how the Simplicity Series 32 balanced pan conveyor operates, how advantages are gained by use of rear drive, and what methods of suspension are made possible by these designs. Three drive assemblies are pictured and described, and their use with conventional or balanced pan conveyors is explained. Series 32 conveyors can be equipped with grizzly decks, side extensions, double carrying surfaces, screen cloth, or perforated plate. *Simplicity Engineering Co.*

For more facts, circle No. 25 p. 81-82

Simplified Drafting

36-page booklet, *"Simplified Drafting,"* presents in clever, dramatic manner 11 common sense rules for simplifying drafting practices. Through medium of sample drawings of engineered parts and assemblies, the 11 rules—from the use of word descriptions for simple parts -to- making free-hand drawings wherever possible—are illustrated and a straightforward comparison made between traditional and simplified methods. Simplified drafting methods make it possible to cut, by 40-50 per cent, time to complete a given volume of work. *American Machine & Foundry Co.*

simplified drafting

methods (like styles) change with the times

For more facts, circle No. 26 p. 81-82

Arc Furnaces and Hot Topping

"The Indirect Arc Electric Furnace Development and Application" is the fea-

ture article of the June-July issue of *Carbon and Graphite News.* Listed are 13 advantages of these furnaces along with applications to ferrous and nonferrous melting and investment casting. Another article deals with reducing crop losses with electric arc hot topping. *National Carbon Co., Div. of Union Carbide & Carbon Corp.*

FOR MORE FACTS, CIRCLE No. 27 P. 81-82

Sand Bin Flow Persuader

Restricted, interrupted, or irregular flow from sand bins and hoppers is solved with PneuBin. Bulletin shows how strategic placement of these pneumatic, diaphragm panels in bins, and pulsations of compressed air cause material to flow without arching or funneling. PneuBin operates quietly, ends repairs to battered bin walls, is easily installed, reasonably priced and economical to operate, is dependable, and easily controlled, eliminates poking down, and allows dust tight tops on bins. *Gerotor May Corp.*

FOR MORE FACTS, CIRCLE No. 28 P. 81-82

Quality Gray Iron Casting

12-page booklet tells how a group of foundries producing gray iron castings are able to put out a superior product. They have replaced obsolete equipment, added mechanized equipment, and more efficient handling methods for reduced costs and faster production. They have 22 individual control points in the production of castings. Know-how is shown in their approach to gating and risering to produce sound castings efficiently. *Reecemelt.*

FOR MORE FACTS, CIRCLE No. 29 P. 81-82

Portable Moisture Tester

True reading of free moisture content of sands, clays, and other materials used in the foundry can be determined in 40 sec with the Speedy Moisture Tester described in Bulletin AL-36. It is portable, requiring no special set-up or electrical connections, and is not affected by vibration or being set up off level. Simple operation does not require weights or calculations; moisture per cent is read directly from dial. *Alpha-Lux Co., Inc.*

FOR MORE FACTS, CIRCLE No. 30 P. 81-82

Melting and Holding Pots

Refax pots are used for melting and holding applications in aluminum

foundries and die-casting operations where high quality, low alloy, nickel-chromium cast iron retards oxidation and solution attack. Have increased toughness and durability without sacrificing machinability. Bulletin lists dimensions and capacities for holding pots, tilting pots with pouring spouts, bottom drain pots, and special shape pots. In addition die-casting goosenecks, ingot molds for non-ferrous metals, and utility castings are described. *ACF Industries, Inc.*

FOR MORE FACTS, CIRCLE No. 31 P. 81-82

Molding Machine

Specifications of Type B.T. pneumatic jolt, squeeze, turnover, and pattern draw molding machine are given in 14-page booklet. Special features include absence of flask clamping, jolt timer, quick mold removal, protection from sand with built-in air filters, simple foundations, automatic lubrication, and cleaning ease. One model has 400-lb jolt capacity, 26x19-in. table, 19-¾-in. clearance, 8-in. pattern draw, and takes flasks up to 21 in. wide. Other model has 1000-lb jolt capacity, 36x28-in. table, 30-¾-in. clearance, 12 ½-in. draw, and takes up to 29 in. wide flask. *British Moulding Machine Co., Ltd.*

FOR MORE FACTS, CIRCLE No. 32 P. 81-82

Palletizing Service Bulletin

"Palletizing of Bulk Materials" illustrates typical palletizing of Hydrecon refractory castables, Franco and Super Franco Plastic firebrick and Franset, France and Francite High Temperature Mortars. Included is complete breakdown in tabular form by packaged unit and arrangement per pallet including total drums or bags per pallet, and number of containers flat and high. *J. H. France Refractories Co.*

FOR MORE FACTS, CIRCLE No. 33 P. 81-82

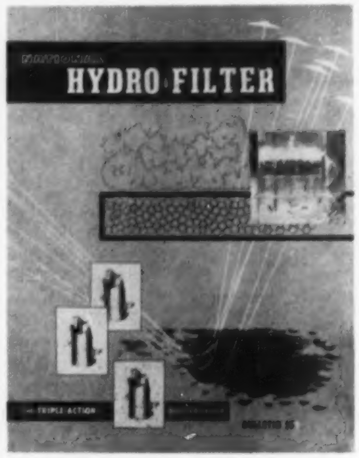
Sand Separators and Blenders

Bulletin SS-54 tells how the following foundry problems are solved with Royer sand separators and blenders: surface defects, drops and pattern slides, blows and runouts, low permeability, hot sand, expensive hand riddling, excessive new sand requirements, costly facing sand, proper grain size distribution, high grinding and cleaning costs. Construction, operation, and capacities of this Royer line are included along with illustrations of applications to conveyor feeding, muller discharge, tractor-shovel loading, and manual feeding. *Royer Foundry & Machine Co.*

FOR MORE FACTS, CIRCLE No. 34 P. 81-82

Filtering Dust Collector

12-page Bulletin 55 offers specifications and descriptive details of the National Hydro-Filter. Covered are details on how the unit traps dust by impingement on glass spheres, entrapment on bubble surfaces, and containment with



in water droplets. Separating efficiencies, application data, construction, and design as well as description of models and capacity range available and description of laboratory and test facilities are included. *National Dust Collector Corp.*

FOR MORE FACTS, CIRCLE No. 35 P. 81-82

Pyrometer Supplies

How you can obtain closer temperature control, save time, and reduce costs. Better protecting tube construction increases sensitivity by closer fit, offers greater permanence of calibration by use of best alloys, and longer life by extra heavy seamless construction. Time is saved by improved thermocouple head design; inspection takes only 20 sec, replacement, 45 sec, no disconnecting lead wires, no bent thermocouple wires. Costs are reduced by specializing solely on pyrometer supplies which are listed in 15-page catalog. *Arklay S. Richards Co., Inc.*

FOR MORE FACTS, CIRCLE No. 36 P. 81-82

Pickle House Equipment

New booklet, "Equipping the Pickle House," is offered as a practical guide to greater production at lower cost in a wide variety of pickling operations. More than 70 photographs illustrate practical applications of Monel in sling chains, yokes and special hooks, crates, racks, baskets, drums and other batch handling accessories. A number of dia-

grams and a table of link specifications showing safe loads for Monel chain are also included. A final chapter illustrates and describes the machining, welding, shaping and forging of Monel, and lists Inco's technical bulletins which provide complete details on these operations. *International Nickel Co., Inc.*

FOR MORE FACTS, CIRCLE No. 37 P. 81-82

Materials Handling Equipment

Condensed catalog No. 554 containing 50 pages of technical data, brief description and photographs of vibratory equipment, feeders, conveyors, power tools, shaft seals, diesel pile hammers, gasoline hammers, selenium rectifiers and other materials handling equipment, has been published by *Syntron Co.*

FOR MORE FACTS, CIRCLE No. 38 P. 81-82

Arc Furnace Transformer

12-page illustrated brochure GEA-6236 is a comprehensive guide to assist arc furnace users in preparing specifications for transformers. Included are optional features for particular applications. Construction and operation of the wedge-type tap changer is described. Weights, dimensions, and cooling-water requirements for 750 to 15,000 kva transformers are tabulated together with approximate low-voltage values at full and reduced capacity, and total reactance. *General Electric.*

FOR MORE FACTS, CIRCLE No. 39 P. 81-82

Flask Selection and Maintenance

Factors determining flask size, cope depth and amount of sand, flask design and construction, pin arrangements, clamping determination, bushing and pin tolerances, and flask barring are covered in 24-page, 4x6 booklet, "How to Select and Maintain Foundry Flasks." *Sterling Wheelbarrow Co.*

FOR MORE FACTS, CIRCLE No. 40 P. 81-82

New Molding Sand Conditioner

Announcement of Liquaflour tells how it gives physical properties of many materials to molding sand. Advantages listed are: it is not dusty; replacing carbon materials now used, it gives a strongly reducing atmosphere; castings peel excellently, have less penetration and burn-on, and fewer expansion defects; rigid sand control is not necessary; only ¼ to 1 per cent Liquaflour

is used; less temper water is needed; high flowability sand produces pattern detail finish, less ramming and more molds per hour, and it permits hard ramming too. *Whitehead Brothers Co.*

FOR MORE FACTS, CIRCLE No. 41 P. 81-82

Rubber Conveyor Belt Story

"The Story of Hewitt-Robins, 1891 to Now" is a 24-page booklet telling how the company started, its products, and how they are distributed. Except for tire manufacturers, *Hewitt-Robins* is the world's largest producer of rubber products. It is the only organization making both rubber belting and machinery components for belt conveyor systems.

FOR MORE FACTS, CIRCLE No. 42 P. 81-82

Grinding Hints

"Rough Grinding" is a 60-page, 5x7-in. booklet on abrasives and bonds, wheel selection, floorstand grinding, portable grinding, finishing welds, swing frame grinding, wheel shapes, core files, rubbing blocks, wheel evaluation, grinding costs, and speeds. *Norton Co.*

FOR MORE FACTS, CIRCLE No. 43 P. 81-82

Automatic Sand Proportioning

Technical Reference 55A describes automatic proportioning of foundry sand and core binders and outlines the various requirements of a typical foundry proportioning operation. Two methods for meeting these requirements are presented. Eight photographs and two drawings of Richardson equipment and phases of the proportioning operation are included. *Richardson Scale Co.*

FOR MORE FACTS, CIRCLE No. 44 P. 81-82

Industrial Trucks

Bulletin 54B lists complete range of industrial trucks, including gasoline-powered, electric platform, electric crane and battery-powered fork trucks. Also included are the Gas-O-Matic and the Baker Traveloader, a side-loading handling and carrying truck. Illustrated bulletin includes tables of dimensions, capacities, weight, lift height, and other specifications for each model, series and type. Descriptions of special features and other data to aid in proper selection and application, are also included. *Baker-Raulang Co.*

FOR MORE FACTS, CIRCLE No. 45 P. 81-82

Identification Stamps

Catalog 146-A Series is a 50-page listing of Matthews Industrial Marking Products. Shows character styles for stamp letters, numbers, and symbols and type holder styles. Inspector's hammers and special equipment are described. *Jas. H. Matthews & Co.*

FOR MORE FACTS, CIRCLE No. 46 P. 81-82

Cupola Refractory Ramming Mix

Bulletin AL-30 tells of Luxit-O, an acid base, high grade refractory with a fusion point of 3136 F prepared especially for gray iron foundry practice. Shipped in moisture-proof drums, Luxit-O gives up to 5-day service for 8 and 16-hr heats in front slagging breasts. Front slagging spouts lined entirely of Luxit-O have up to a 2-week life. It eliminates block or brick in cupola wells. Lining medium or large ladles with Luxit-O eliminates brick and takes only 45 min for a 1-ton ladle; life, exceeds brick lining. *Alpha-Lux Co., Inc.*

FOR MORE FACTS, CIRCLE No. 47 P. 81-82

Sight and Eye Safety

Sight and eye safety are portrayed in a 14-page booklet, "Only One Pair to a Customer." Compete coverage of the eye, how it works, how it can be injured, and what steps can be taken to aid recovery are presented along with a description of how Magic Lens tissue solves lens cleaning problems. *Silicone Paper Co. of America, Inc.*

FOR MORE FACTS, CIRCLE No. 48 P. 81-82

Flexible Metal Hose

12 types of interlocking, flexible metal hoses are described in Bulletin 50-B. Construction, types of metals available, ranges of sizes, metal thickness, are included as are complete data on diameters, bending radii, weights, packings, and fittings. *Atlantic Metal Hose Co.*

FOR MORE FACTS, CIRCLE No. 49 P. 81-82

Industrial Heating Facts

"Handbook of Oven Facts" is 20-page bulletin (No. 555) covering discussion of heat, fuel cost comparisons, and design elements. Common formulas for calculating heat and oven requirements are included along with basic concepts of industrial heat processing and heat control. *Michigan Oven Co.*

FOR MORE FACT, CIRCLE No. 50 P. 81-82

let's get personal

Steel Founders' Society of America will move its headquarters from 920 Midland Building, Cleveland 15, to 606 Terminal Tower Building, Cleveland 13, as of August 4, 1955. The new quarters provide a mild increase in floor space with more convenient arrangement and improved service facilities.

P. C. Will has resigned his position as vice-president in charge of engineering of the Hydro-Blast Corp., to go back to his former field of municipal engineering. He is now associated with Edwin Hancock Engineering Co., Chicago.

Professor Edwin R. Shorey has retired from the Department of Mining and Metallurgy, Univerity of Wisconsin. He has been with the department for 36 years and retires as chairman. The chairmanship was assumed July 1 by **Professor Philip C. Rosenthal,** of the same department.

Vernon H. Patterson has been named manager of foundry sales of Climax Molybdenum Co., New York. Mr. Patterson joined the Detroit Metallurgical staff of Climax in 1949. He will develop an organization of specialists in the use of molybdenum as an alloying material by foundries and will be responsible for the national sales of molybdenum to the foundry industry. His headquarters will be in New York. **John F. Robb,** appointed head of steel industry sales, will continue to make his headquarters in Pittsburgh.

Alexander Zeitlin has been elected vice-president of Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., and Pittsburgh. Mr. Zeitlin will continue to head as president Engineering Supervision Co., New York, recently acquired by Birdsboro.

Lester Dean, president of Massey Supply Co., and **Joseph Bloom,** retired, both of Kansas City, Mo., have been elected to the board of directors of Lithium Corp. of America, Inc.

Ford R. Snyder was named vice-president of Hickman, Williams & Co., with headquarters in Chicago. He was recently elected a director of the company. **H. Charles Jones**

Prof. P. C. Rosenthal . . chairman

Prof. E. R. Shorey . . retires

was named secretary and **Rickman Powers** was appointed treasurer. Jones and Powers will headquarter in Cincinnati. Mr. Jones was also elected to the board of directors recently to succeed C. H. McNeill, who retired.

J. A. Rassenfoss . . Research mgr.

John A. Rassenfoss has been appointed manager of the Manufacturing Research Laboratory of American Steel Foundries and **C. G. Mickelson** and **P. J. Neff** have been appointed assistant managers. Manufacturing Research Laboratory is a consolidation of what was formerly known as the Research Laboratory and the Process Development Department. Its headquarters are in East Chicago, Ind.

C. F. Mayer, Jr., . . president

Carl F. Mayer, Jr., vice-president and general manager of Carl Mayer Corp. since 1951, has been elected president and treasurer, succeeding

For more facts, circle No. 68 p. 81-82

his father who died in April. The new head of the firm has worked with his father for more than 10 years in management, design and engineering of industrial ovens and furnaces. The firm also announced the election of **L. C. Baker** as vice-president and **B. C. Boer** as secretary. Mr. Mayer, Sr., before his death, was a well known professional engineer and inventor in his field, and was the recipient of the Trinks Award in 1952 for outstanding achievement in the industrial heating industry.

F. P. von Meyer . . prod. mgr.

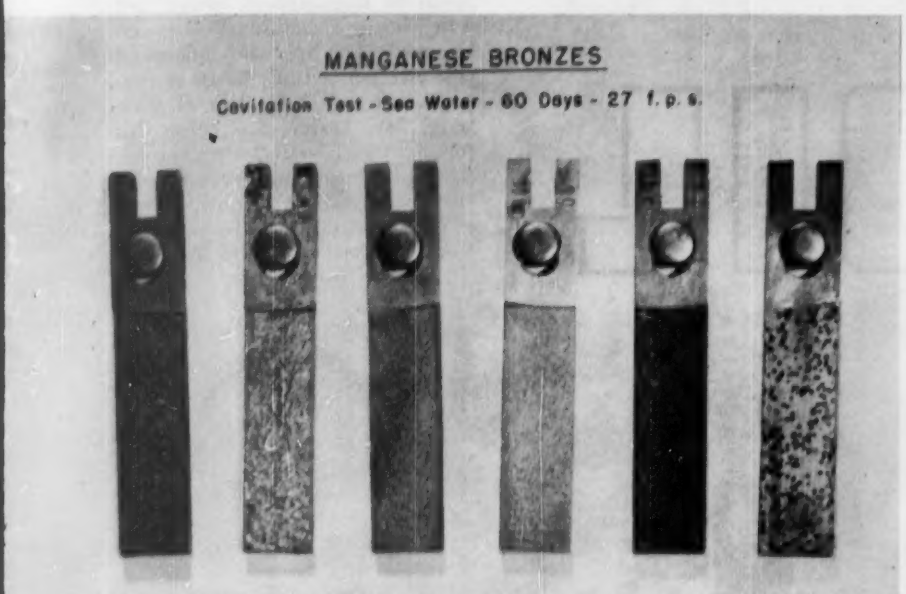
F. P. von Meyer has been appointed production manager of the Manufacturing Div., W. H. Anderson Co., Inc., Detroit. Prior to joining Anderson, he was production manager of the Bearing Div., Bohn Aluminum & Brass Corp., Detroit.

T. L. Humble . . Aluminum v-p

Thomas L. Humble has been appointed vice-president and general manager in charge of production at Aluminum Industries, Inc., Cincinnati. He will direct their recently announced expansion program.

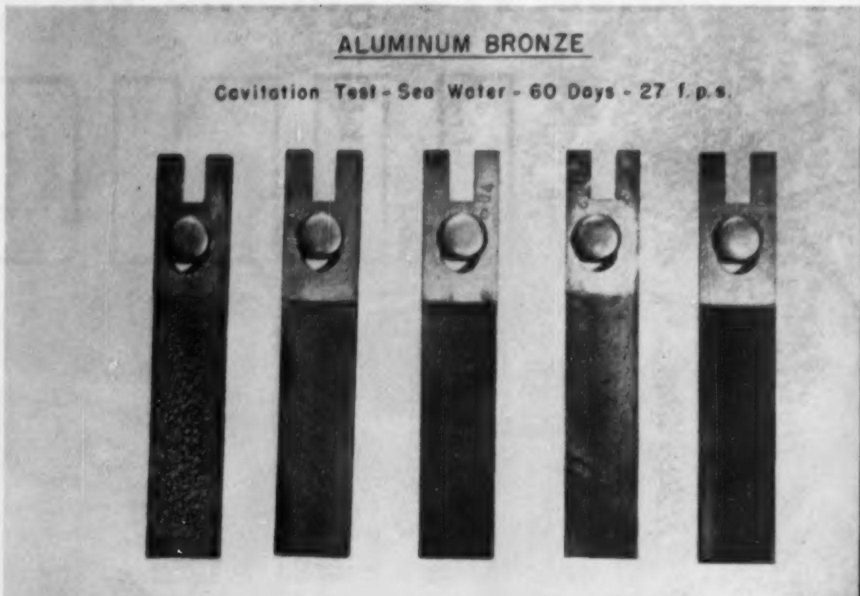
Continued on page 69

What's *NEW* in Aluminum Bronze?



o.	38AB(1) 05	38AF(4) 04	38AD(2) 04	38AE(3) 03	38AG(5) 04	38AH(6) 04
pper	56	52	58	58	58	60
nc	Bal.	44	36	34	36	32
on	.7	.3	.60	.80	.83	.80
uminum	.7	None	1.1	1.50	1.0	3.2
nganese	.7	.7	.40	.50	1.80	.36
ckel	-	2	3	5.2	3.3	3.2
rrosion ate-Mdd	380	387	279	211	164	60

Fig. 1 . . Appearance and composition of specimens suggests . . .



No.	33AP 01	75AB(7) 03	75AD(9) 04	33AR 02	75AC(8) 03
Nickel	-	3	5	5	5
Aluminum	10	10.4	10	10	10.5
Iron	4	3	3.9	4	2.75
Manganese	2.5	.50	1.45	2.5	3.3
Copper	Bal.	Bal.	Bal.	Bal.	Bal.
Corrosion Rate-Mdd	236	160	90	66	40

Fig. 2 . . a somewhat selective process of deterioration.

Castings of the first one-piece nickel-aluminum bronze ship propeller is a major achievement of the foundry industry. Here is the study that led up to it

JAMES S. VANICK/*Research Metallurgist*
International Nickel Co., Inc., New York

■ Manganese and aluminum bronzes differ fundamentally in that manganese bronze is built upon a brass base while aluminum bronze is built upon a copper base. Both bronzes depend for their high strength characteristics upon a phase change, a recrystallization somewhat similar to that of steel wherein pure iron, which is weak and ductile, is changed to steel which is strong and hard. The 30 to 40 per cent zinc in manganese bronze, moves this product a long way toward the formation of the strong, hard, beta phase which develops high strength. Small amounts of supplementary alloys, such as iron, manganese, and aluminum, finish the task by raising the strength rapidly.

In the copper-aluminum alloy, aluminum additions under 8-1/2 per cent produce relatively small changes in the strength, but above 8-1/2 per cent, the strength and hardness increase steeply and reach the 90,000 psi levels at about 10 to 10-1/2 per cent aluminum. Increasing the aluminum content hardens the alloy further but at the expense of toughness, so that at 12-1/2 per cent aluminum, the composition is relatively brittle and has a hardness exceeding 300 Brinell.

As in the case of steel where 75 per cent of the tonnage applications are accommodated by the tough, lower-carbon steels (0.30 to 0.40 per cent carbon), so also most aluminum bronze applications split the composition range of 8-1/2 to 12-1/2 per cent aluminum and settle down to work at about 10-1/2 per cent aluminum. For many applications it is now sufficiently strong and adequately tough to accommodate the stresses and strains incident to casting as well as fabrication.

At the 10-1/2 per cent aluminum

level, the composition is alloyed with helpful additions of iron, manganese, and nickel. The resulting complex compositions have been bracketed into four grades through the activities of the American Foundrymen's Society and American Society for Testing Materials. Table 1 shows these four alloys and their range of mechanical properties.

Since composition 9D delivers top strength, it is natural for foundrymen to look upon it as the alloy that contains the best combination of properties. In addition to tensile strength and hardness, engineering properties include resistance to heat, corrosion, and wear; while the less commonly discussed proportional limit, modulus of elasticity, specific gravity, etc., are extremely important to the designer dealing with engineering applications.

Foundrymen need to revive some of their adventurous spirit and modify these alloys when necessary to meet competition from other materials. Modifications to composition 9D to improve its corrosion resistance, toughness, and proportional limit, have been found desirable. The following text will endeavor to map these changes and point out applications for which they become desirable.

The aluminum bronze family, as it is known to foundrymen, has received research attention over many years, and its history is too extensive to be itemized at this time. It will be sufficient to point out that a comprehensive bibliography was prepared by Jerome Strauss' in 1927, while he was a member of the staff at the Naval Gun Factory at Washington, D.C. Since then, the Copper and Brass Research Association, in its book, *Aluminum Bronze*, last revised in 1947, brings 250 additional references under observation.

Since 1947, interest has continued and a number of important contributions have been made. This article includes several items of research from activities of the Bayonne Research Laboratory, International Nickel Co. Credit for their development belongs to J. T. Eash, R. A. Kozlik, G. L. Lee, and F. L. LaQue. Others whose contributions have been helpful are J. J. Fitzgibbon, Whitehead Metal Products Co., New York, and staff members of the Baldwin-Lima-Hamilton Corp., Philadelphia, and the Bethlehem Steel Co., Shipbuilding Div., Bethlehem, Pa.

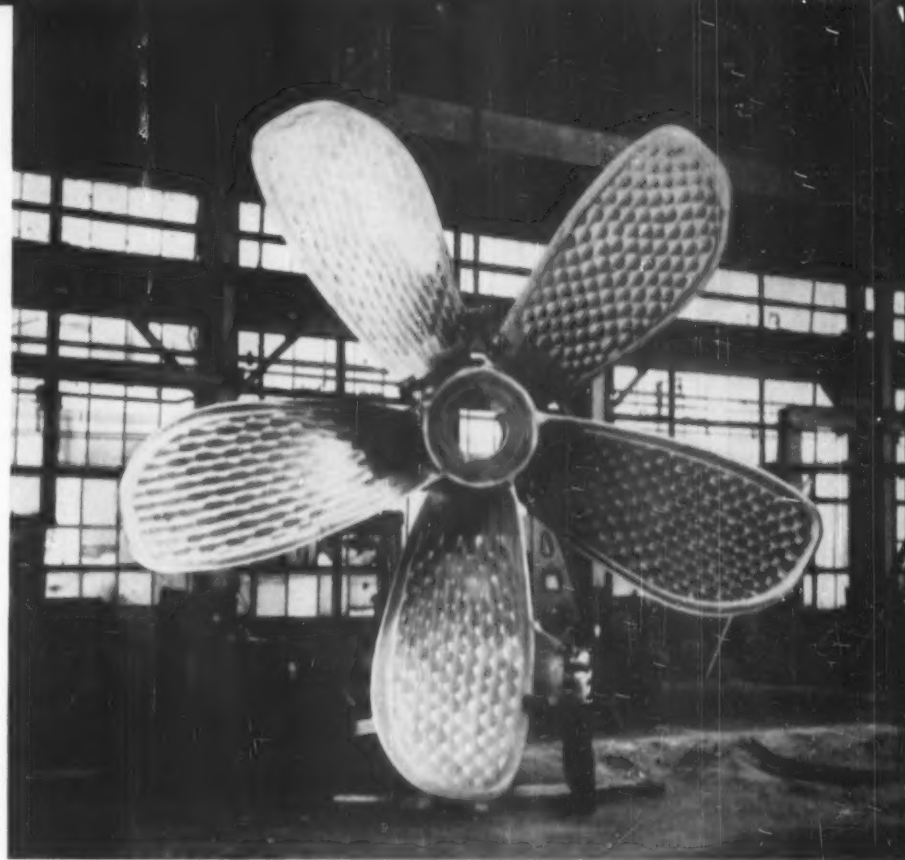
Erosion and Corrosion Resistance. Industrial application of bronzes relies mainly on their corrosion resistance. In mild corrosives, bronze insures the functioning of the equipment for a lifetime. This would apply to manganese or aluminum bronzes when immersed in motionless fresh or salt water. Turbulence or agitation of water rapidly accelerates corrosion, and when agitation is sufficiently rapid, erosion or cavitation step in. These accelerated, damaging conditions apply partic-

Table 1 . . Nominal Compositions and Properties for Aluminum Bronze Sand Castings (from A.S.T.M. Specification B148-52)

Product	A.S.T.M. Spec No. B148-52	Cu min	Al min	Al max	Mn max	Ni min	Ni max	Fe min	Fe max	Tensile min psi	Yield min psi	Elong. min %/2 in	Hardness Brinell No.
Aluminum Bronze	Grade 9A	86	8.5	9.5	....	....	....	2.5	4.0				
As Cast										65,000	25,000	20	200
Aluminum Bronze	Grade 9B	86	9.0	11.0	....	....	....	0.75	1.5				
As Cast										65,000	25,000	20	110
Heat Treated										80,000	40,000	12	160
Aluminum Bronze	Grade 9C	83	10.0	11.5	0.5	....	2.5	3.0	5.0				
As Cast										75,000	30,000	12	150
Heat Treated										90,000	45,000	6	190
Aluminum Bronze	Grade 9D	78	10.0	11.5	3.5	3.0	5.5	3.0	5.0				
As Cast										90,000	40,000	6	190
Heat Treated										120,000	60,000	5	200

Fig. 3 . . Nickel-aluminum bronze hub and 3-ft blades for adjustable pitch propellers for Navy mine sweepers and landing craft.

American Manganese Bronze Corp., Philadelphia



Baldwin-Lima-Hamilton Corp., Philadelphia

Fig. 4 . . 20-ft diameter cargo vessel propeller in nickel-aluminum bronze carried ornamental spangled polish after 2-yr service.

Table 2 . . Sea Water Erosion Tests on Brass and Bronze Using Submerged, Rotating Wheel
(60-day Tests—Sea Water 30° C—at 27 ft per sec)

No.	Alloy	Cu	Sn	Zn	Pb	Al	Ni	Mn	Fe	Corrosion Rate IPY**
		Analysis				(per cent)				
1	Red Brass	86.3	4.7	4.8	3.9	..	..	..	..	0.061
2	G Bronze	86.9	9.4	2.7	0.15	..	0.9	..	..	0.039
3	Special Mn Bronze*	Bal	..	9.72	..	5.32	5.0	0.75	0.93	0.015
4	Ni-Al Bronze	Bal	..	Trace	..	10.0	3.96	1.14	4.94	0.017
5	Ni-Al Bronze	80.0	..	..	..	10.0	5.0	1.0	5.0	0.005

*Damage to regular manganese bronze ranges from 0.010 to 0.030 IPY, depending upon seasonal temperature, etc.
**IPY = Inches Penetration per Year.

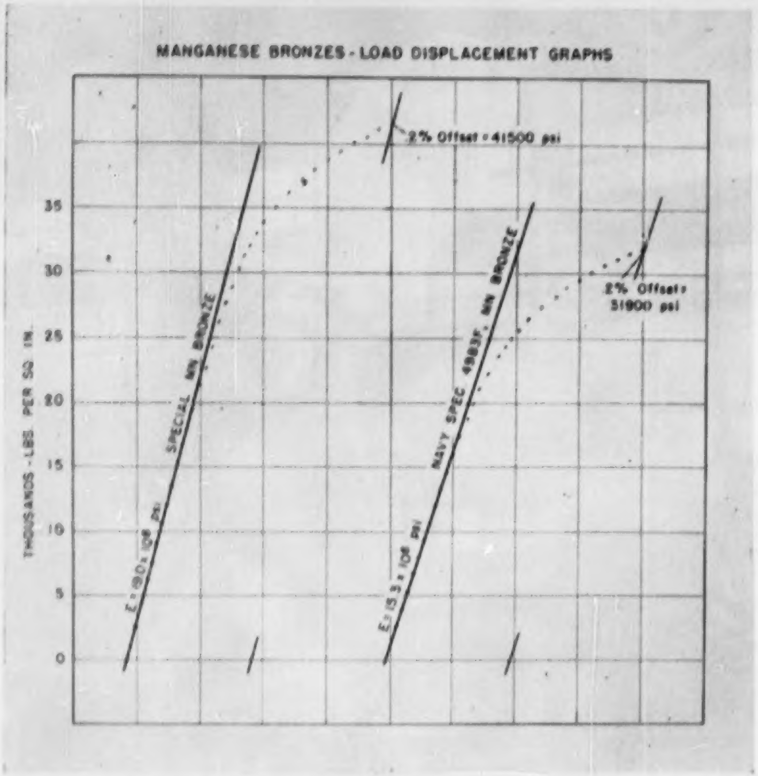


Fig. 5 . . Strength and stiffness of Table 5 compositions 61 and 62.

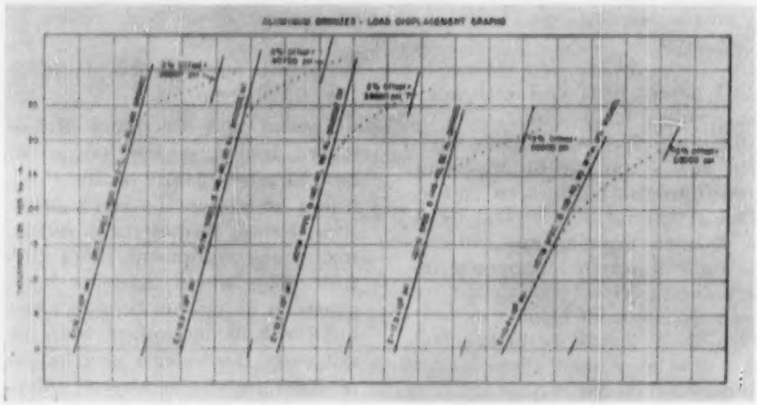


Fig. 6 . . Table 5 compositions 3 to 7 are identifiable by E values.

ularly in the case of marine propellers.

The advantage of aluminum bronzes over manganese bronzes for propeller service was determined in sea water erosion tests and reported in earlier publications (Tables 2 and 3). The author[2] presented some of this earlier data and additional evidence appears in Beeching's vibratory tests[3] in Table 4.

Recent tests[4] in sea water showed that marked improvements in the erosion resistance of manganese and aluminum bronzes might be expected by adjusting the nickel, manganese, or aluminum contents of these alloys.

The quality of the corrosion attack on manganese bronzes suggested that a somewhat selective process of deterioration might be expected. Figure 1 summarizes their

Table 3 . . Sea Water Corrosion Tests on Nickel-Aluminum Bronzes
(Arranged in order of merit)

Quiet Exposure			Jet Tests(a)			Rotating Wheel(b)	
No.	Mdd(c)	Max. Pit Depth(d)	No.	Mdd(c)	Max. Pit Depth(e)	No.	Mdd(c)
1	3.6	0	5	5.6	3	5	99
6	3.6	0	8	8.7	5	8	138
3	. .	7	3	nd	6	3	134
8	8 1	44	6	nd	7.6	6	129
5	13.05	45	1	nd	8.4	1	192

(a) Jets velocity at 12 ft per sec—water at 86F (30 C) for 30 days.
(b) Submerged rotating wheel—at 84.6F (27 C) and 27 ft per sec for 60 days.
(c) Mdd = milligrams per sq decimeter per day weight loss.
(d) Pit depth in mils for 442 days.
(e) = Pit depth in mils for 30 days.
nd =not determined.

Analysis (per cent)

No.	Cu	Al	Ni	Fe	Mn
1	Bal	7.5	. .	0.02	. .
6	Bal	7.5	2.3	0.02	. .
3	Bal	7.6	2.4	0.09	. .
8	Bal	10.6	3.4	2.5	0.04
5	Bal	10.6	5.1	2.5	0.7

composition, corrosion rate, and appearance. Nickel and aluminum substantially decreased erosion, while excessive zinc increased it.

Eliminating zinc as a component and increasing the aluminum content to 10 per cent, put the alloys in the aluminum bronze classification. The appearance of aluminum bronze specimens, their composition, and corrosion rate values are shown in Fig. 2.

Aluminum bronzes, particularly those containing 3 to 6 per cent nickel and iron in addition to their quota of 10 per cent aluminum, had substantially reduced erosion damage, resulting in a surface that was smoother and more uniform after exposure.

For the time being, the improved corrosion rate of the high (3.3 per cent) manganese alloy 75-AC of Fig. 2 had to be set aside until the alloy could be more thoroughly studied from the standpoint of specific engineering properties including its behavior in the foundry. The risk of encountering embrittlement in these alloys due to an excessive quantity of the beta phase, required such precautions. In the foundry, the fluidity, viscosity, and "burning in" tendencies of high manganese alloys invited further study.

Alloy 33-AR (Fig. 2), a composition within the brackets of the standard A.S.T.M. B148 (9D) composition, had an extensive history of production and application. Its engineering properties and foundry habits had been more thoroughly studied and, to improve its performance in these respects, the aluminum content had been reduced close to the 9.5 per cent level. Since its resistance to cavitation was six times greater than that of the prevailing propeller-type manganese bronze and since there was no risk of dezincification such as occurs in manganese bronzes, at-

Table 4 . . Results of some Cavitation Erosion Tests Using the Vibratory Method

Type of Alloy	Analyses (per cent) Ni	Zn	Al	Fe	Mn	Cu	Other	Hardness Bhn	Tensile Strength psi	Elongation %	Wt. Loss mg Last 60 min of exposure — Salt Water
	Admiralty Mn Bronze							156	80,300	27	18.9
Cast	8.0	39	0.3	0.5	0.3	Bal	—	156	85,000	36	13.9
High-	5.9	21	2.6	1.6	1.8	Bal	0.5 Sn	145	86,000	18	11.2
Tensile	5.0	10	5.0	1.0	1.0	Bal	—	101	88,800	28	9.5
Brasses	3.4	31	3.7	1.7	2.1	Bal	—	175	89,500	20	8.9
	12.6	41	1.0	1.0	2.0	Bal	—	175	89,500	15	8.8
Cast	2.9	5.3	7.4	2.8	1.9	Bal	—	128	79,500	27	6.3
Aluminum	4.3	1.3	8.6	3.8	1.7	Bal	—	154	86,000	27	4.6
Bronzes	5.0	—	9.7	5.1	0.1	Bal	—	169	89,900	24	4.8
Cast Gun Metals and Tin Bronzes of 88-10-2 and 85-5-5-5 types								—	30-40,000	13-35	19-28

tention was concentrated upon the production and application of this alloy for propellers. In addition, it possessed a high yield strength, ample toughness, and other desirable propeller properties such as hardenability and weldability.

20% Weight Saving

The selection of 33-AR for marine service brought into design higher modulus of elasticity and lower specific gravity. These could be combined to produce a 20 per cent lighter propeller whenever the extra weight in existing designs was not needed to increase resistance to erosion. Some of the data supporting these attributes follow:

Propeller castings in smaller sizes had been made of the A.S.T.M. B148 (9D) material for the past several years. Figure 3 illustrates the smaller propellers of this alloy. Early in 1953, the Baldwin-Lima-Hamilton Corp. produced several castings of this alloy in the 20-30 ft diameter and 20-30 ton weight ranges (Fig. 4).

Inspection standards of the various authorities governing marine applications, have been met in the case of the nickel-aluminum bronze alloy, and the propeller specification of 80,000 psi minimum tensile, with 15 per cent minimum elongation, has been exceeded by 20 per cent. In the case of large propellers, test bars are taken from coupons attached to the blades and hub and machined to standard dimensions.

Specs are Too Broad

A.S.T.M. specification B148 (Table 1) for aluminum bronze, is too broad to permit adequate selectivity as compositions may vary over a wide range. The emphasis is upon tensile strength. High strength values are easily produced by increasing aluminum contents which progressively lower the toughness of the alloy while increasing its hardness and strength.

If this were a steel specification, the condition would be duplicated if it merely called for "steel" and required 80,000 psi minimum tensile strength. In the case of steel, this requirement could be met with a forging steel, a die steel, a drill steel, or a tool steel. All of them would have ample strength. The forging steel, with its low carbon base plus alloy composition, could develop the high strength that is required, along with an ample degree of ductility. The remaining steels could be made to possess high strengths and a high hardness, but they would register unusably low elongations. It is for this reason that specifications for steel are separated into the multiple grades now listed in handbooks to provide the designer with a material that specifically fits his needs.

Steel Does It this Way

Some time ago, George Dreher[5] emphasized the significance of similarly controlling the aluminum bronze compositions. He stated: "The control of these alloys to achieve desired results follows the path laid down by steel metallurgists in the production of their alloys. After all, there is no common sense in assuming that bronzes can be loosely composed when the analysis of steel must be held to 0.10 or 0.01 per cent in order to duplicate results. By applying some of the technique of the steel makers, the producers of aluminum bronze have been able to alter that practice to suit their problem, and have come up with results analogous to those expected of the most advanced steel and iron castings and rolled products."

Improvement of propeller bronzes was specially studied in connection with this work, and specified test values of 80,000 psi minimum tensile strength and 15 per cent elongation were set as basic requirements. For design purposes, it was also important to know about the yield strength. The advantages that may be developed in improving the yield strength, stiffness and toughness of these bronzes, represent an important portion of this contribution.

Yield Increased 20-30%

Figure 5 charts the strength and stiffness of a special manganese bronze composition compared with a propeller-type manganese bronze. The addition of 5 per cent nickel and 5 per cent aluminum, with a substantial reduction in the zinc content, raised the yield strength and elastic modulus considerably. Deformation measured with a Berry strain gage while lacking the fine accuracy of an Ewing gage, provided a clear picture of the changes in yield strength and elastic modulus with changes in composition.

Table 5 summarizes the tensile properties of some of the manganese and aluminum bronzes whose corrosion rates are shown in Fig. 1 and 2. Figure 6 shows that the nickel-free aluminum bronze (Alloy No. 5 of Table 5) had a modulus of about 11,000,000 psi while the nickel-alloyed types developed 18-19,000,000 psi. The propeller-type manganese bronze in Fig. 5 developed approximately 15,000,000 psi. Tests showed that a 20 to 30 per cent increase in yield strength could be developed in aluminum bronzes when additions of 5 per cent nickel were made to the tougher and lower aluminum-content types of this alloy. Stress-strain curves for Alloy No. 5 Table 5, con-

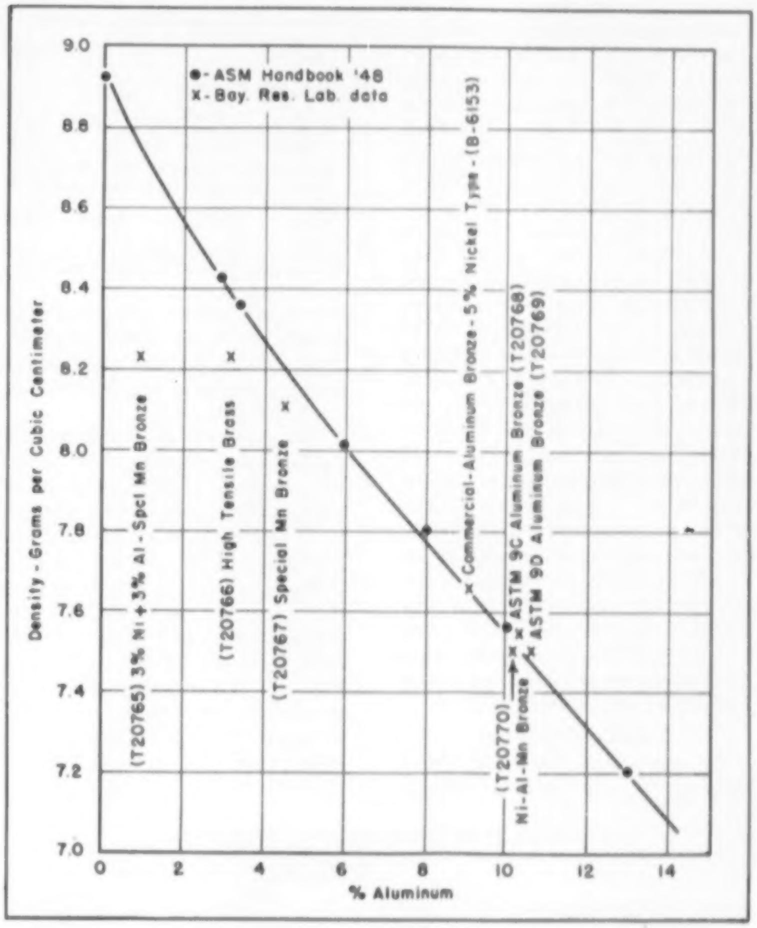


Fig. 7 . . Ni-Al bronze props may be 10-20% lighter than Mn bronze.

Table 5 . . Comparison of Propeller-Type Manganese and Nickel-Aluminum Bronze Alloys

No.	Type	Composition (per cent) Cu	Al	Fe	Ni	Zn	Mn	Tensile psi	Yield psi 0.5% Offset*	Modulus of Elasticity x10[6]	Elongation %/2 in.
1	Manganese	57.4	1.2	0.94	...	39.6	0.54	79,500	33,950	15.3	21
2	Manganese Special	77.8	4.5	1.1	4.94	10.9	0.60	76,300	42,400	19.0	17
3	Aluminum	83.0	10.4	3.1	2.96	...	0.54	83,100	33,100	17.9	17.5
4	"	78.4	10.5	2.74	4.94	...	3.32	83,600	38,950	18.7	15
5	"	Bal	10.0	4.0	...	...	2.5	93,750	29,550	10.4	15
6	"	Bal	10.0	4.0	5.0	...	2.5	92,500	42,500	18.9	13.5
7	"	79.8	10.0	3.9	5.0	0.47	1.45	95,750	40,500	18.1	17

*Figures 5 and 6 plotted for .20 per cent Offset.

taining no nickel, show a 30,000 psi yield strength, while its companions No. 4 or No. 7 registered values close to 40,000 psi yield strength.

A further comparison between Alloys 4, 6, and 7 shows that iron and manganese additions may increase the tensile strength without changing the yield strength appreciably. These results provide a clear picture of the common effect of nickel increasing the stiffness and yield strength of copper-base alloys.

Compositions and properties of the seven alloys described in Fig. 5 and 6 appear in Table 5. This table records yield strengths at 0.5 per cent offset, whereas Fig. 5 and 6 show the values for 0.2 per cent offset; the difference is not impressive. Alloy No. 7, which is preferred for propellers at this time, possesses an ample margin in excess of the 80,000 psi minimum tensile strength and 15 per cent minimum elongation specified. For test results upon two separately made 18-ft diameter propellers of nickel-aluminum bronze see Table 6.

Table 8 . . Properties of Cast Nickel-Aluminum Bronze upon Slow Cooling*

Alloy No.	Composition (per cent) Cu	Al	Ni	Mn	Fe	Condition	Tensile	Yield 0.5% Offset	Ratio YS/TS	Elong. %/2-in.	Reduction of Area %	Bhn
ASTM 9D	78 min	10-11.5	3.0-5.5	3.5 max	3.0-5.0	As-Cast	90,000	40,000	0.45	6.0	..	190
9D-2	(83.5)	(10)	(0)	(2.5)	(4)	As-Cast	93,750	29,350	0.31	15.0	16.2	174
Same as 9D-2, cooled to 900°F, held 4 hrs + FC to 600°F							88,750	29,850	0.34	14.0	16.3	..
9D-3	(78.5)	(10)	(5)	(2.5)	(4)	As-Cast	92,500	42,500	0.46	13.0	13.7	187
Same as 9D-3, cooled to 900°F, held 4 hrs + FC to 600°F							91,000	43,900	0.48	8.5	11.5	..
Same as 9D-3, cool for 80 hours at 20°F/hr from 1800°F to 200°F							77,250	32,600	0.42	13.5	15.9	..
16 in. diam. Ingot	81.55	9.63	5.31	0.88	2.07	Ingot Center—	77,500	38,000	0.51	9.5	..	170
						Edge—	76,800	37,200	0.50	11.0	..	..

*Numbers in parentheses indicate nominal composition, all others are analyzed.

Slow Cooling Effects

In the earlier stages of development of the nickel-aluminum bronze alloy, some concern was expressed over the possibility that slow cooling in the mold might cause a deterioration of mechanical properties.

The problem of stabilizing the mechanical properties of aluminum bronzes in large sections resembles the corresponding problem in steels. Aluminum bronzes proceed through microstructural transformations that are similar to those that occur in quenched and tempered steels. These effects in their basic form are related to the cooling rate. To simplify the understanding of the problem, it is easiest to draw from the experience of more than 50 years of intensive study on steels and relate some observations that apply to aluminum bronzes. Briefly, this relationship is as follows:

Steels may be made to develop high strength and hardness by increasing their carbon contents and applying quenching treatments which fit the cooling rate to the composition. Where metal sections are small, the cooling rate can function effectively. Where the sections are large, slower transfer of heat through the metal governs the conditions of cooling in the center of the mass. Steel men meet this situation by alloying the metal sufficiently to control the transformation to fit the cooling rate. This refinement in control enables them to develop high strengths or hardnesses in heavy sections.

Iron & Nickel Added

Aluminum bronze follows a parallel course. It is possible to develop high strength and hardness by merely increasing the aluminum content. The resulting alloy, like its high-carobn steel counterpart will become brittle and will frequently register this condition by developing cracks upon cooling. The composition may be adjusted to a lower aluminum content and further alloyed to eliminate the softening transformations brought about by the slower cooling rates which occur in heavy sections or in heaps of production castings. The principal alloying ingredients are iron and nickel. Both are essential and lend a grain refining effect to the material. Iron is needed to improve control of the mechanical properties and supplement nickel in this respect. The influence of iron upon a chill-cast thin-section alloy of this type is shown in Table 7.[6]

The need to place some limitation upon iron is induced by its tendency to accelerate corrosion attack when present in excessive amounts. Since aluminum bronze is fundamentally a corrosion-resisting alloy, it is essential that it retain this basic quality as fully as possible. Nickel enters the system then to contribute its strengthening, grain refining, and transformation retarding effects and improve corrosion resistance. The importance of using at least 5 per cent nickel for this purpose is demonstrated in Table 5. The function of nickel in raising the yield strength from a 30,000 psi level to a 40,000 psi level, without appreciably changing the tensile strength, is illustrated in comparing 9D-2 and 9D-3 of Table 8.

Work recorded in Table 8 was undertaken to demonstrate that very slow cooling, such as might occur in the heavy mass of a large propeller hub, would not produce any appreciable damage. Results indicate that the risk of "self anneal" that occurs in some aluminum bronze alloys, should not occur in the 5 percent nickel-5 per cent iron type of alloy.

Functions of Nickel

Metal cooled at a very slow rate for a period of 80 hr, still retains a high proportion of its expected strength and toughness when alloyed with 5 per cent nickel and 5 per cent iron. Test pieces cut from a 16-in. diameter ingot of a somewhat under-alloyed composition of this grade of aluminum bronze, similarly register a high level of yield strength and toughness, indicating that mechanical properties are not seriously damaged by a very slow rate of cooling. These data re-emphasize the point that the function of nickel in this composition is to raise the as-cast yield strength, stabilize the structure against deterioration due to slow or variable cooling rates, and

Table 6. . Tests of Coupons from 18-ft Propellers

No.	Test Piece Location	From Specimens Attached to Casting: Tensile psi	Yield psi	Elongation %/2-in.
Specified		80,000	..	15
A	Hub	81,500	38,000	37.5
A	Blade	89,500	35,000	27.5
A	Blade	88,500	34,500	32.5
B	Hub	82,000	40,000	25.0
B	Blade	86,500	39,000	21.0
B	Blade	88,500	38,000	25.0

Working Specifications

	Ni	Al	Fe	Mn	Zn	Pb	Sn	Cu
Desired	5.0	9.5	4.0	1.5	None	None	None	80
Allowed	4.5-5.5	8.5-10.5	3.0-5.5	3.0 Max	0.05 Max	0.01 Max	0.05 Max	Bal

Mechanical Properties: 85,000 TS min; 35,000 YS min; 18% Elongation min; some values of tensile strength have exceeded the worinkg specifications to reach 95,000 psi with a 20 per cent elongation level.

Table 7 . .Effect of Iron on Nickel-Aluminum Bronze Die Castings*

Composition (per cent) Ni	Fe	Mn	Al	Cu	Hardness V.D.H. 30 kg. Load	Tensile Strength Tons per sq in.	Elongation per cent
5.01	0.34	0.49	8.26	Bal	171	35.5	18
			8.65		192	38.0	14
			9.17		220	44.3	12
			9.65		240	47.2	9
			10.07		275	49.5	9
			10.57		272	48.5	5
4.95	5.21	0.52	7.87	Bal	190	30.0	18
			8.14		194	36.0	15
			8.40		211	42.5	13
			9.20		240	48.5	13
			10.17		270	54.5	7
			10.65		290	57.5	6
			11.22		296	63.8	6

*—All test bars were cut from the castings which were ¼in. thick in section.

Table 9 . . Density of Aluminum and Manganese Bronzes

Heat No.	Density g/cc	Density lb/in³	Al	Ni	Zn	Mn	Fe	Cu
T20765	8.21	0.297	0.92	3.25	35.5	1.82	0.83	57.6
T20766	8.22	0.297	3.19	3.19	32.3	0.36	0.79	59.86
T20767	8.11	0.293	4.49	4.94	10.88	0.58	1.09	77.81
T20768	7.54	0.272	10.35	2.96	—	0.54	3.09	82.96
T20769	7.50	0.271	10.50	4.49	—	3.32	2.74	78.43
T20770	7.50	0.271	10.07	5.00	0.47	1.44	3.92	79.84
B-6153	7.65	0.276	9.1	4.72	0.48	0.55	4.29	80.9

thereby maintain or improve the resistance to corrosion.

The metallography which underlies the nickel and iron alloying effects in aluminum bronzes is as complicated as that relating to the production of microstructures of martensite and bainite types in steels. In comparison with steels, the work upon aluminum bronzes has been insignificant. It would be best, at this time, to recognize the need for much additional work on aluminum bronzes and accept the parallel relationship temporarily—namely, that cooling rate effects in this bronze can be controlled by properly alloying it with nickel and iron to produce (without heat treatment) commercial castings with stabilized mechanical properties.

Strength-Weight Ratio

An incidental advantage to propeller construction is the reduction in weight per unit volume, accompanying the addition of aluminum to the alloy. Figure 7 charts the progressively decreasing density of compositions listed in Table 9. Designers expect the 20 to 30 per cent greater yield strength and 10 per cent lesser weight to enable them to make nickel-aluminum bronze propellers 10 to 20 per cent lighter than those of manganese bronze.

Aircraft designers have for some time made use of the high strength-to-weight ratio of nickel-aluminum bronze in their application of copper-base alloys to engines and control equipment. Wrought, cast and die-cast shapes are commonly used. The high order of resistance to heat, to cavitation, and to corrosion made it inevitable that the alloy would engage attention for those applications requiring a performance superior to brasses of the manganese bronze-type or to the tin bronzes.

The time had come in 1953 for converting the experience of casting small ship propellers of this alloy family, into the giant castings that the marine shipping industry uses. In the United States, the Baldwin-Lima-Hamilton Corp. cast the first 20-ton propeller under the supervision of B. A. Miller and his staff. Dozens of these propellers have been made since. A dry dock inspection of the first casting after 24 months' service on a cargo vessel, indicated that it was living up to expectations from the cavitation and corrosion standpoint by still carrying its ornamental spangled polish which should have been worn away within a year had it been made of propeller-type manganese bronze.

An actual reduction in metal thickness can be observed for specimens in Fig. 2 after 60 days at 27 ft per sec. In contrast, an 18-ft propeller at 90 rpm would have its blade tips moving at 80 ft per sec over an 80 per cent portion of the 9-months' service.

News of similar progress in Great Britain with an alloy of this type, preceding U. S. developments, has been reported in the technical press.

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AFS Library Open for Business

■ A library for the world-wide castings industry has been established at American Foundrymen's Society headquarters. Hundreds of books have been catalogued under the Dewey Decimal System of classification since last March and the library is already in operation.

Housed in the new AFS Technical Center in Des Plaines, Ill., the library is in direct charge of Miss Nancy R. Purucker, a graduate of the University of Pittsburgh. Miss Purucker worked at the Mellon Institute throughout her school years, indexing and abstracting technical reports. She stayed at the Mellon Institute for six months after her graduation in 1951, then joined the Zonolite Co. research laboratory in Evanston, Ill. She served as libarian at Zonolite for three and one-half years and adapted the company's library needs to a punch card system.

Since joining AFS in March, Miss Purucker has cataloged nearly 500 technical books. She is organizing subject order files of current periodical material and eventually plans to develop a subject heading classification system which can be used by foundry libraries everywhere. No such system exists at present.

The library now receives more than 100 current trade and scientific journals, both domestic and foreign, of interest to the foundry industry. These periodicals are scanned for important information and then are circulated to specified members of the AFS staff. Finally they are returned to the library for clipping and filing.

Bound copies of AMERICAN FOUNDRYMAN, AFS TRANSACTIONS, and 12 other periodicals are maintained by the library.

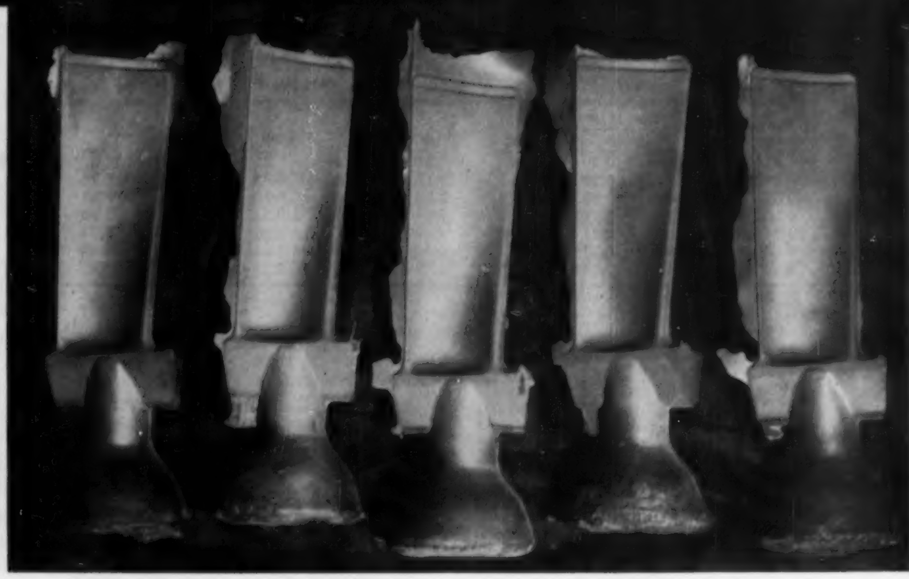
The library has started a fine collection of historical books through gifts from Mrs. R. A. Moldenke, Robert E. Kennedy and Bruce L. Simpson, and others, and is currently accepting foundry, metallurgy, and engineering books of all types.

Inauguration of the library greatly expands AFS services to members.

Specific questions can be answered and the librarian will attempt to locate hard-to-find information. The Society has joined the Special Libraries Association which will aid in locating obscure facts.

Library doubles as conference room for AFS committees and staff meetings. Here while Librarian Nancy Purucker makes literature search, safety, hygiene, and air pollution control committee workers and staffers review manuscript for forthcoming air pollution control manual. Seated (clockwise starting left): Wm. N. Davis, former AFS safety and hygiene and air pollution control director (now manager of exhibits); H. T. Walworth, Lumbermen's Mutual Casualty Co.; F. A. Patty, General Motors Corp.; E. M. Adams, Dow Chemical Co.; H. J. Weber, SHAPC director of AFS; R. J. Ruff, Catalytic Combustion Corp.; and D. E. Gilchrist, Deere & Co.

1 As-cast jet engine buckets of cobalt alloys were pressure cast at temperatures up to 3000 F into wirebound, unsupported glass shells preheated to 1600 F.



2 Extremely light sand blast exposes absolutely blemish-free surfaces of better than 40 micro inch finish. Grain size control is comparable to investment castings.

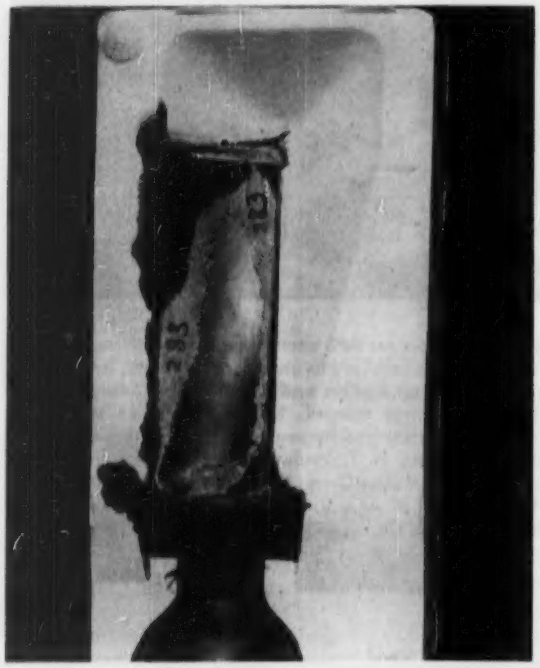
RICHARD M. SMITH/*Plant Engineer*
Corning Glass Wokrs Corning, N. Y.

THEY'RE MAKING
MOLDS out of GLASS now

New process uses ceramic slip of crushed, almost pure silica glass to make shell molds for exceptionally smooth castings.

NICHOLAS J. GRANT/*Assoc. Prof.*
Massachusetts Institute of Technology

3 Cast bucket still in one half of glass shell. Thin sections are easily cast as shown by 0.002-0.005 in. flash beyond 0.020 in. section.



■ Glass has moved into the shell molding picture. A new process of producing shell molds uses a silica glass powder mixed with water to produce a casting slip. When dried and fired, the slip gives a shell mold with exceptional surface finish and dimensional tolerances equal to investment castings.

Prominent in this development, known as the Glascast Process, has been the Corning Glass Works which supplies the glass powder used in the casting slip.

Glascast molds are exceptionally resistant to thermal shock, making possible high preheats and fast cooling rates without danger of mold cracking. Glass shells are poured at 3200 F after being preheated to 1800 F.

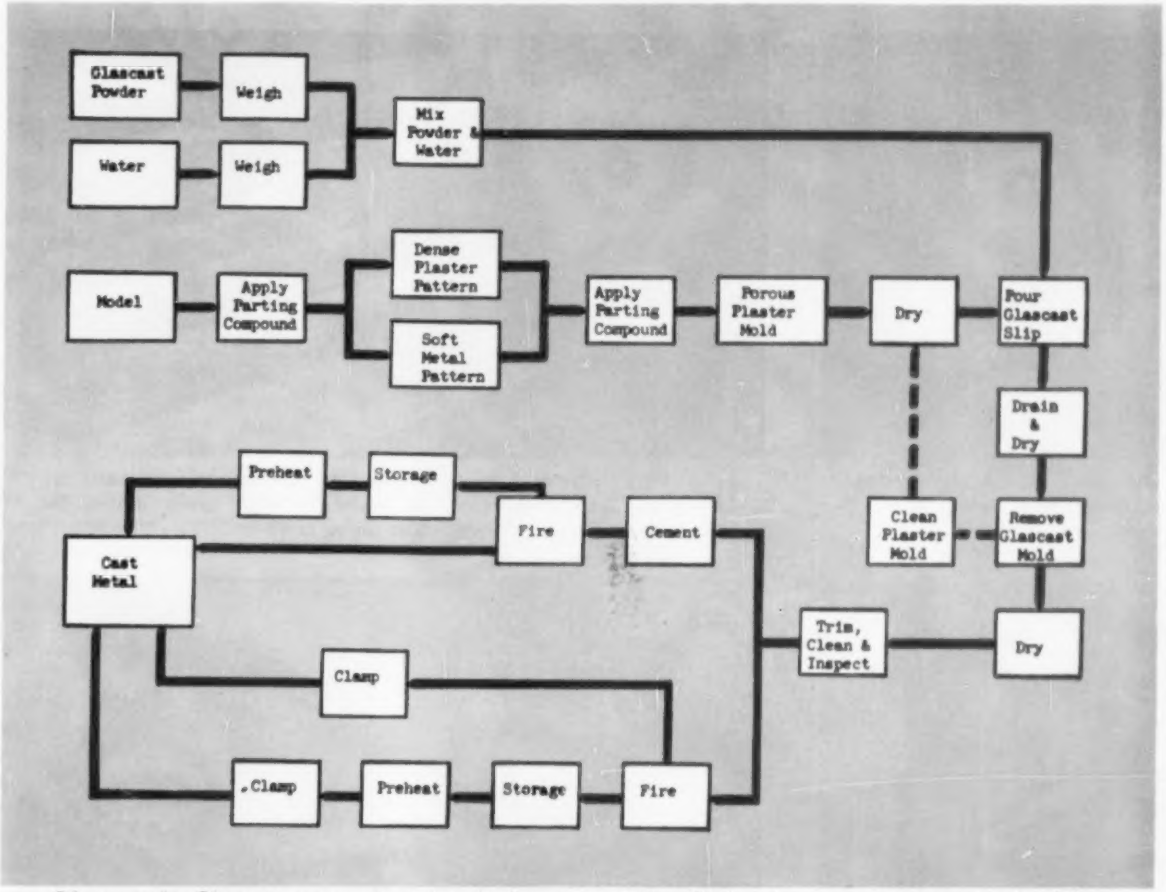
In test production of parts such as jet engine buckets, 90 per cent of the finished castings were absolutely blemish free with better than 40 micro inch finish.

Easy to use, Glascast powder is essentially a finely crushed (-325 mesh) 96 per cent pure silica glass, mixed with water to produce a casting slip. No binder is required. Poured into a pourous plaster form, the slip builds up into a glass shell which is dried, removed from the mold, and fired. The shell is then ready for use without further treatment, may be poured immediately at fired temperatures or cooled and stored indefinitely.

Low tool-up costs make short runs practical and hold-up time from mold preparation to casting is greatly reduced.

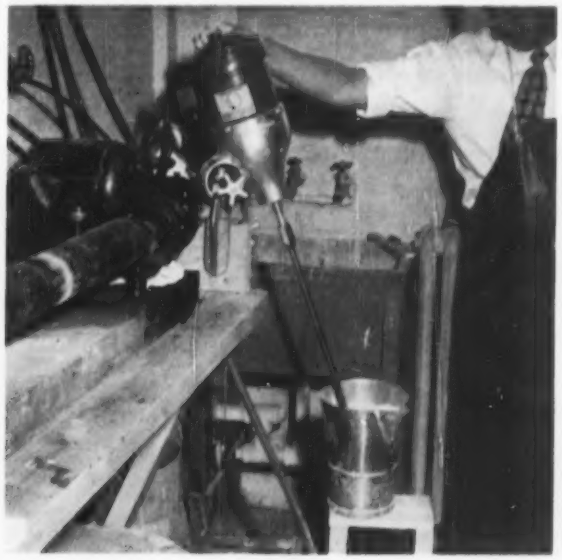
Standard equipment includes a model, containers for slurry, scales, mechanical mixer, dry oven controllable between 105 and 300 F, and firing furnace ranging to 2000 F.

Inherently the process promises dimensional control of 0.005 in./in. Parting line variations, however, constitute the major process difficulty. Current development is aimed at correcting this condition.

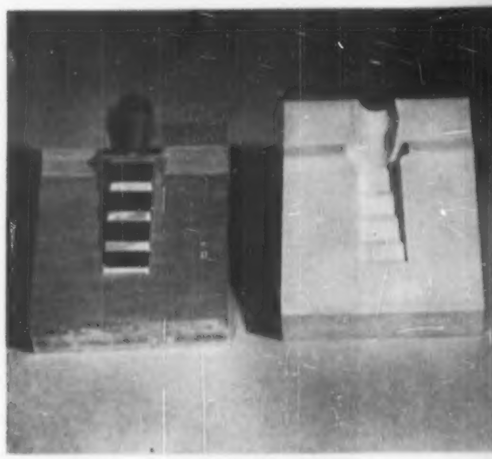


4 Of course the Glascast process chart doesn't show that highly-skilled artisans aren't necessary, that Glascast slip lasts indefinitely, or that glass shells are completely stable at room temp or 1800 F.

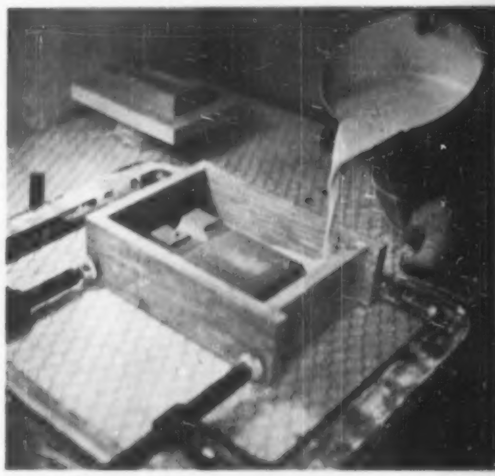
5 First step in the Corning Glascast Molding process is weighing and sifting of plasters for the mold pattern and also for the plaster mold in which the glass shell forms and sets-up.



6 Supplier mixing ratios and procedures should be closely followed. Pattern plaster is strong, smooth surfaced, with low expansion. Molds may be of a high grade pottery plaster.

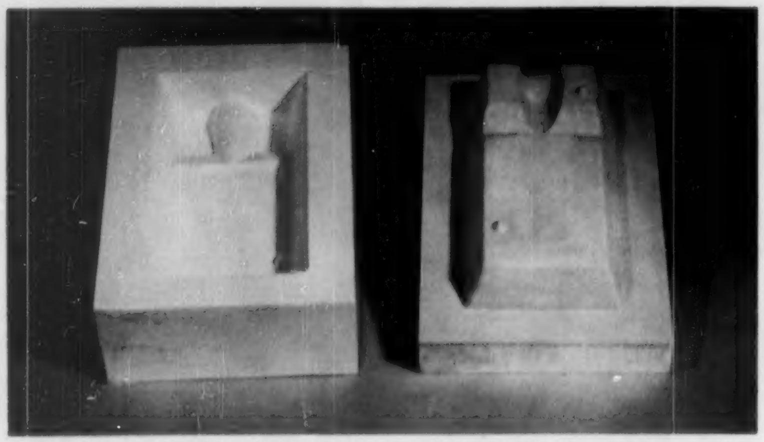


7 Model, profile, and first dense plaster mold pattern. Model and pattern are used to make other half-mold pattern.



8 Suitably parted pattern is enveloped with a slurry of porous plaster. Economics may allow plastic or metal patterns.

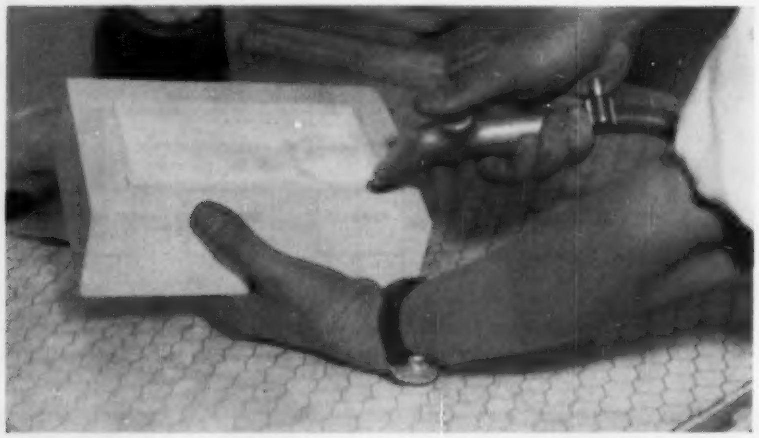
9 Repeated applications of a Bayberry wax-gasoline mix not only seal plaster pattern but also is excellent parting.



10 From 15 to 20 glass shells may be made in the plaster mold before there is some surface and dimensional deterioration. If this is not critical, up to 100 and more impressions can be made.

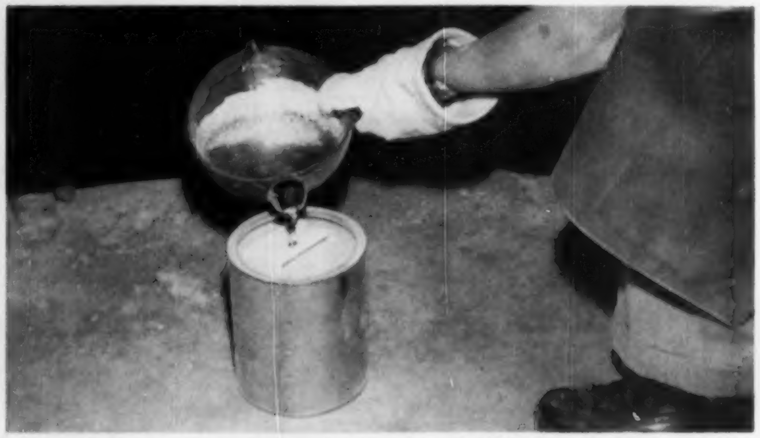
11 Casting Glascast slip is prepared by dispersing four parts by weight powder in one part water by high speed mixing for ½ hr; or by rolling in capped bottles for up to 48-hr.

12 After cleaning and wetting plaster mold cavity, slip is poured in and then out after allowing 5-10 min for mold to absorb enough water to build up a ⅛-in. shell of glass.



13 Dried for 10-15 min at 140 F, the glass shell is removed with a fine jet of low pressure air, by inverting and tapping free, or by broad ejection pins in a production set-up.

14 Oven dried at 200 F, shells are inspected, fitted, then placed in 1740-1920 F furnace for about ½ hr. Shells may be stored indefinitely in a dry place or poured immediately.



15 Glascast shells, assembled with stainless wire, tape, or cement, may be preheated and/or backed cold with refractory material and static, pressure, centrifugal, or vacuum cast.

■ If you are not actually planning to convert your acid electric furnace to basic the chances are that you have been giving it some thought. Usually one or more of the following developments have prompted your thinking.

1. Chemical specifications are getting lower and tighter on phosphorus, and in particular on sulphur for steel castings.

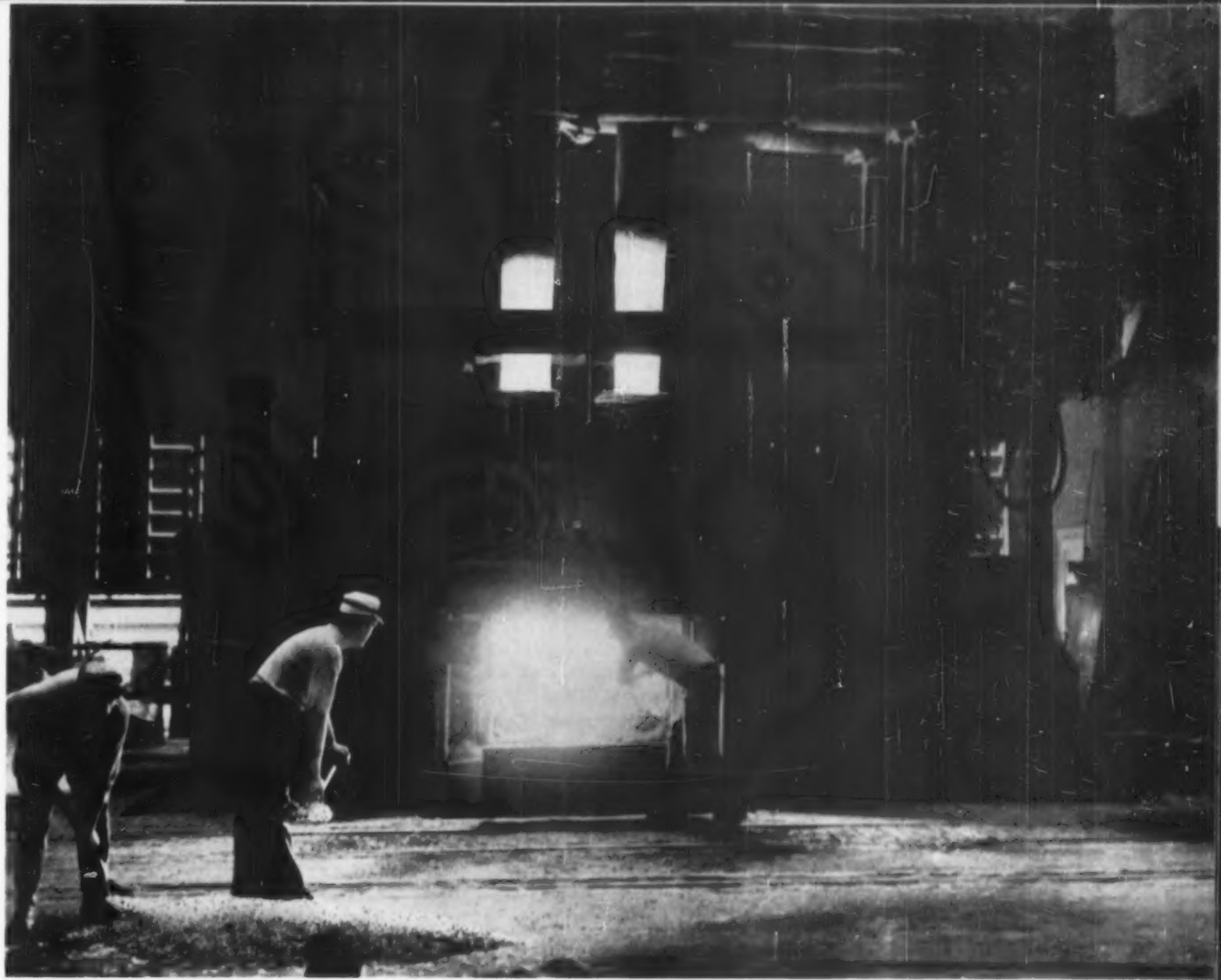
2. Reliable low-phosphorus and low-sulphur scrap is getting scarce in many areas.

3. If you make stainless steels or certain other high-chromium steels, the maximum allowable carbon contents are getting lower all the time; or, conversely, the very low carbon grades command a premium price.

4. Ferrochromium and some other alloys are still expensive enough to warrant even drastic steps to conserve them. A good basic electric furnace practice is a practical answer to any one or all of these problems; but it's not all rose blossoms. There are some sharp thorns on the vine.

Estimate Possible Savings. It is not contended that these four reasons are the only valid ones for attempting a basic practice; there are those who, making high manganese steels of the Hadfield types, must use a basic operation because of the corrosive character of their particular slags and metals. But if you are considering it for other reasons, make certain that you have some tangible gain which you can express in dollars and cents before you buy a lot of expensive basic refractories. For instance, "We'll run basic for a month or so, just to get the experience, in case we ever have to convert" is not a good enough reason.

First of all it is difficult if not impossible to generate enough enthusiasm under this attitude to insure a successful or even an adequate operation. Second, you may never have to convert or the time may be so far in the future that everyone will have forgotten the experience. Third, when the time comes that you must convert, you'll learn quickly enough. Besides there are many capable people willing to give you practical help. Most other furnace operators are happy to make suggestions and impart valuable information and certain alloy, refractory, and equipment companies will lend you an experienced man to help you get started.



Almost all favorable features of basic melting rest upon additions of burned lime.

LET'S MAKE BASIC STEEL

If you decide to switch, don't let the first setback throw you. You'll meet plenty of problems in converting to basic

Savings gained through the attainment of adequately low phosphorus and sulphur levels with cheaper scrap and through the ability to make premium grades of stainless scrap and high carbon instead of low carbon grades of ferro-alloys are not too hard to visualize. Besides, the prospective savings have been clearly and carefully discussed in some recent papers. [1], [2], [3], [4], [5] After a careful study of this excellent literature and applying the information to your own operations, you can answer this question: Disregarding differences in furnace operating costs, how much money can we save by making better steel with cheaper raw materials and/or lower ferroalloy consumption?

Estimate Probable Extra Costs. If a saving is indicated, evaluate it in dollars per ton of steel produced. If this comes to three dollars or more per ton, the chances are that you can probably evolve a satisfactory basic practice. However, it is best to calculate your extra furnace costs on a more individual basis. For our purposes it is not practical to find the best basic furnace practice and expect to emulate that immediately nor should we hope to achieve even average results when we first start out. However, during the first six months or year of operation you should expect your new basic electric furnace practice to compare to your acid practice somewhat as follows:

JOHN P. HOLT/*Sales Engineer*
Basic Refractories Inc., Cleveland

■ Roof life will be about 1/3 of the roof life when making acid steel.

■ Sidewall life will be about 1/2 of acid sidewall life. However, sidewall life can be as much as doubled by using a refractory gun and the proper basic gun refractory.

■ Ladle lining life will be about 1/3 of your present lining life.

■ Bottom and bank maintenance will require 1/2 as much dead burned dolomite by weight as your present acid furnace requirements for furnace bottom sand.

The bottom should last indefinitely if it is properly cared for, but you had better count on at least one, probably two replacements during the first year and about one new bottom every five years if you are making carbon or low alloy steels, or a new bottom every year if you are making stainless with oxygen. In addition, the bottom and banks will require small but regular amounts of a magnesia ramming mix to patch deep holes or repair the banks. If your furnace operation is intermittent (say one or two shifts per day) or if very high temperatures or long heat cycles are necessary you may need rather substantial amounts of this refractory.

Heat time on a charge-to-tap basis may be 30 per cent greater, but on a tap-to-tap basis only about 20 per cent greater, reflecting the expectation that the basic furnace bottom will generally be in much better condition when you tap than is your acid bottom.

Rates of electrode consumption and power consumption, cost of fluxes and deoxidizers, and some other things show significant differences individually; but when they are all lumped together the differences tend to cancel out.[8] For our purposes we can ignore them for the present and, later, when your basic furnace has reached a stable operating condition, you can make such a study.

Admittedly, all of this looks to be a bit arbitrary. However, strictly documented information of this kind is non-existent. Moreover, since people and the shops they run differ so much, precise data acquired at one shop could never be used exactly anywhere else. These statements attempt to be useful approximations and they simply represent the author's opinion based on the observation of a number of shops where conversion from acid to basic took place. Some of these conversions were successful whereas others proved to be uneconomical. Subjecting the unsuccessful attempts to the foregoing analysis in retrospect shows them now to be destined to failure. It actually comes down to this: If you have good acid practice which produces satisfactory steel for your castings, weigh all the operating and cost factors carefully before changing to basic operations.

In calculating roof cost, figure on using the same brick you use on your present acid furnace. However, sidewalls of basic furnaces should be constructed of basic brick. Some operators of smaller furnaces believe that the upper sidewalls should be lined with silica brick. These brick are cheaper, but they drip silica on the banks making the banks harder to maintain. It is the author's contention that this offsets in great part savings in brick cost and consequently has little bearing on projected cost estimates. Magnesite, magnesite-chrome, and chrome-magnesite brick may be used for upper sidewalls, too. However, many electric furnace operators have found the metal encased chrome-magnesia brick more satisfactory. The brick below the slag line should be burned magnesite brick. The monolithic bottom should be constructed of a magnesia ramming mix. You will use this same refractory for patching deep holes in the bottom. Routine repairs to the slag line and banks should be made with a rice-sized, dead-burned dolomite. You should determine the delivered price of all these materials to your plant and calculate the refractory cost including the extra labor needed for more frequent relinings.

Basic Electric Operation. Now let's consider some operating characteristics of a basic electric furnace which differ markedly from acid furnace practice. These differences may be placed in two groups. In the first group are those related to refractories and in the second are those differences related to chemical reactions of the basic slag.

The refractories to be used in a basic electric furnace have been discussed elsewhere in this article and by the author in a previous paper.[7] However, a few general remarks concerning those characteristics of basic refractories which may have an influence on the steel melting would seem to be in order.

First of all, let us never forget that these refractories are chemically basic. Consequently, any substances which contain acid oxides, like silica or alumina, should neither be mixed with nor used in conjunction with any basic refractory. The reason for this injunction is, of course, that such mixtures can form slags with very low melting points; and, especially in the presence of molten iron oxide, these slags may form very rapidly and can cause serious damage to the furnace. Perhaps the emphasis on this point might seem unnecessary were it not for the fact that furnacemen frequently attempt to use such mixtures. However, it is easy to understand the temptation. Most basic refractories are grainy, gravelly substances whose plasticity is quite inferior to good fireclay. The addition of fireclay to a basic granular refractory substantially increases its plasticity, but it does so only at the cost of great damage to their refractory properties.

Under the usual service conditions and, speaking very generally, basic refractories can retain their refractory properties to much higher temperatures than can silica or fireclay refractories. Consequently, it is safe to operate a basic electric furnace at temperatures which may be several hundred degrees higher than the maximum safe temperatures of the furnace with an acid lining.

Advantage may be taken of these better refractory properties because certain desirable chemical reactions proceed rapidly at higher temperatures which were either sluggish, nonexistent, or even reversed at lower temperatures.

Basic refractories in general, under the usual conditions of service in an electric furnace, allow appreciably more heat to escape from the furnace than acid refractories in the same furnace. Sometimes this becomes a problem and sometimes not. Roughly, you can figure on losing twice the amount of heat through a basic lining as you would through an acid lining of the same thickness.

Certain other characteristics of basic refractories should be mentioned here in passing. In general these differences probably would not be noticed during the first few months after conversion from acid to basic because there are so many more important things to occupy the operators. Spalling characteristics of basic refractories differ from those of silica refractories in that the latter have a greater tendency to spall at lower temperatures. Dead burned dolomite, the refractory normally used for hearth maintenance, contains free lime and hence will slake during extended storage. Deterioration may occur in a few weeks if the weather is hot and humid.

Basic Slags. The biggest differences between basic and acid operation are those which are the result of chemical reactions between the steel bath and the basic slag, which are promoted, controlled, or inhibited with furnace additions and changes in furnace atmosphere. It seems that these are the differences which are hardest for the first helper or melter who has been trained on an acid practice to appreciate.

An acid slag ordinarily tends to become more viscous as the heat progresses; and, in part, because of this increased viscosity, it can often practically stop all chemical reactions in the furnace. However, basic slag can be made viscous or fluid at will and with relative ease. Basic slags which are quite watery beneath the electrodes may be completely solidified near the banks. In general, the aim is to produce a relatively fluid slag and keep it that way all through the heat. A fluid slag is especially desirable at the end of the heat so that all the slag will run out with the tap. We come to a very important rule of basic melting and

that is: Tap the furnace at the exact moment the heat is ready.

Reactions which occur in a basic slag may be considered under two groups: Oxidizing reactions and reducing reactions.

Oxidizing Reactions are, in general, the refining ones; and their end result is to remove carbon, phosphorus, sulphur, silicon, and—to a lesser extent—other oxidizable elements like manganese and chromium. The rate at which these reactions occur (indeed, whether or not they actually will occur) is dependent upon three things: temperature, the state of oxidization of the slag as measured by its iron oxide content, and its basicity as measured by its lime-silica ratio.

A more accurate designation of a slag's basicity is sometimes referred to as its V ratio. This ratio takes into account the presence of certain acid oxides like P_2O_5; but the simple ratio of CaO to SiO_2 may be judged by the appearance of slag samples. Changes in the lime-silica ratio are sensitive enough for our purposes.

A slag control program aimed at controlling furnace operation through the appearance of slag samples can help you effect substantial economies. Consequently, you should initiate such a program with the first heat of basic steel you make and keep after it until everyone can read lime-silica ratios and iron oxide contents from slag samples.

Phosphorus removal occurs best at lower temperatures. Consequently if the scrap contains large amounts of phosphorus it is well to charge burned lime or limestone with it. Remember that burned lime and limestone cannot conduct electricity so they should be placed well down in the furnace. However, it is best not to place burned lime directly on the bottom because it may stick there and cause your bottom to build up to such an extent that you may eventually have difficulty melting a full-sized heat. A lime-silica ratio of 2:1 is usually enough to remove phosphorus from low carbon steel.

On the other hand, if you are planning to make higher carbon steel, this will result in a slag with much lower iron oxide contents than is usually present when carbon is lower, and you may have difficulty with phosphorus "kicking back" from the slag to the metal near the end of the heat when the furnace is hottest.

This brings us to another important rule of basic melting: Do not let your furnace get too hot too soon. If you do, you will not only have trouble with phosphorus but with all your furnace refractories as well. Often maintaining a lime-silica ratio of 2½:1 or 3:1 will help prevent phosphorus reversion; but when phosphorus problems are serious, it is usually necessary to take off the early basic slag shortly after the heat has melted and build a new slag with burned lime and a little fluorspar.

Sulphur is more difficult to remove. Although temperature and the state of oxidization of slag have appreciable affects, by far the most important considerations are the lime-silica ratio and the slag volume. A slag of a certain lime-silica ratio can contain only a limited amount of the total sulphur present in the heat. In order to get more sulphur out of the steel and into the slag, either the lime-silica ratio or the slag volume must be increased. Both may be accomplished by adding burned lime. If sulphur is a problem, it is helpful to slag off because you will remove substantial amounts of acid oxides contained in early slags and you can build up a highly basic slag anew.

Despite the widespread convictions to the contrary, it is not necessary to have a reducing slag in order to remove sulphur to low levels. Sulphur cannot be removed from a steel bath unless there is a large excess of lime in the slag and a sufficient slag volume to hold the sulphur in solution. However, an excessively large slag volume presents such problems to the melter that it is often mandatory to remove early slags and the sulphur they contain in order to get your heat to finish low in sulphur.

Another consideration in making basic steel: Do not allow your slag volume to become excessive. Six per cent of the weight of the bath is generally more than enough. If you find that the slag volume is getting too big as the heat progresses, and if the slag does not contain any valuable metal oxides which you later wish to reduce into the steel bath, run the slag off right away so that you don't have to fool with it any longer than necessary.

Silicon removal is rarely a problem in basic steelmaking. Silicon will oxidize and become a part of the slag as long as there is even a little oxygen (or iron oxide) present in the system. However, it is extremely important to remember that silicon, oxidized to silica, becomes an acid constituent of the slag and if the scrap contains large amounts of silicon, you may expect to have your carefully laid plans for removing phosphorus and sulphur upset. In such cases, your only recourse is to run off the first slag and get a fresh start.

Carbon removal can be nicely controlled in basic melting. The iron oxide content of the slag which you maintain by ore additions or by oxygen injection, together with the temperature of the bath determine the rate at which carbon may be removed. As the steel bath becomes lower and lower in carbon content, its temperature must be raised in order to keep the heat from "boiling flat."

In general, heats which boil flat and are tapped in this condition are too cold to pour successfully; so, for the most part, it is best to avoid such an occurrence by keeping the metal hot either by oxygen injections or by adequate power to the electrodes. Thus, you can see that a heat of basic steel which is in good condition as far as temperature is concerned, is also hot enough so that its carbon content is dropping rapidly right up to the time you are ready to tap. Consequently, you must either catch the carbon on the way down by tapping at the precise moment it reaches the desired content and kill the heat in the ladle; or you must block the heat in the furnace by adding silicon. Since, as pointed out above, silicon will not remain in an oxidized bath very long, blocking gives only a temporary respite and you must get the heat out of the furnace before the carbon-oxygen reaction starts again; otherwise, you will have an off-composition heat.

Thus we come back to the first

Proper refractory gun and basic refractory can double sidewall life.

important rule: Tap the furnace without delay as soon as the heat is ready. Since it is impossible to predict exactly when the furnace will be ready to tap, it is imperative that the ladle be in place in back of the furnace well ahead of time so that you can tap the heat on a moment's notice. This is in contrast to certain acid practices where often the heat is made ready to tap and then the melter wanders off down the shop looking for the ladle. Such nonchalance will ruin a heat of basic steel.

Manganese and Chromium. Since high manganese steels and high chromium steels require special melting practices which are not required for low alloy and carbon steels, it would not be wise to encumber this article with description of these processes. However, if we consider manganese and chromium as elements that are either unwanted or at least are desirable only in small amounts, then we can consider them in the general picture.

Basic furnace practice removes manganese and chromium only with difficulty. It is almost impossible to eliminate amounts under one-half of one per cent. It is practically true that you will get in the finished steel whatever small amounts are in the charge. However, both manganese and chromium may be lowered by boiling the heat down until it contains practically no carbon, running this slag off, and finishing the heat under a new slag after recarburizing it. It is easier on refractories and makes for faster heat times if manganese and chromium can be eliminated in the charge if you don't want them in the finished steel.

Chromium has an additional difficult characteristic of being absorbed into the banks when you are oxidizing the heat; and later, while you are finishing the heat, it will sneak back into the steel again to give you an off-composition melt.

Reducing Reactions, in general, enable you to extract valuable elements from the slag. It is true that when reducing slags are sufficiently basic, sulphur removal can occur readily beneath them and, under certain conditions, phosphorus may be extracted from a steel bath under a basic reducing slag. However, it is generally not necessary for most foundries to use a reducing slag unless it is desired to salvage oxidized elements from the slag. The following elements may be recovered from reducing slags, listed approximately in order of the increasing difficulty of reducing them: manganese, chromium, vanadium, columbium, and titanium.

Nickel, molybdenum and tungsten may be reduced from their oxides in an oxidizing slag in the presence of molten iron. Silicon and aluminum require special furnace conditions. Fairly large amounts of silicon and small amounts of aluminum may be retained in a steel bath for long periods of time if the basic slag is kept quite reducing.

The oxidizing power of a slag is a function of the slag's iron oxide content. Conversely, a reducing slag is characterized by a low content of iron oxide. Slags which contain about three per cent iron oxide are ordinarily thought of as mildly reducing slags. A highly reducing slag contains less than one-half of one per cent of iron oxide; such a slag blanket will enable a steel bath to retain appreciable amounts of silicon in solution with little or no loss.

Reducing slags may be prepared in the furnace by adding granular aluminum, silicon, or calcium. These materials may be obtained in various forms such as ferrosilicon, calcium-silicon, and ferrochrome-silicon. There are a number of other such materials available and their particular use depends upon a number of factors such as the steel being made, raw materials available, and the type and size of the furnace. Carbon, in the form of coke breeze or ground graphite, is an excellent reducing agent because it can dissolve in the slag in the form of calcium carbide. In this state carbon goes to work in the slag itself, reducing various metallic oxides. Carbon is also quite inexpensive.

Unfortunately, it is not always possible to use carbon because there is a tendency for the steel bath to pick up carbon from the slag. This is particularly true when the carbon content of the bath is very low. However, in most other cases, even if it is not possible to use coke or graphite for the entire reducing operation, it is quite feasible to save considerable amounts of expensive reducing agents by substituting carbon for a certain percentage of the requirement.

The process of "turning over" a slag from oxidizing to reducing may be accomplished by adding sufficient quantities of the proper reducing agents directly on top of the slag, together with sufficient burned lime to maintain a lime-silica ratio of at least 2:1 after the reducing agents have become oxidized.

The color of slag samples (pulled from the furnace and quenched in water) changes markedly from black or dark grey to brown, bright green, or even white as iron oxide is removed from the slag. Removal of most of the iron oxide does not insure that all of the valuable metals which the oxidizing slag contained have also been removed. It may take another ten or fifteen minutes of holding after the slag has turned over permanently to make sure everything of value has been removed from the slag to the metal.

Frequently after turning over such a slag, the slag volume becomes large and the temptation is to run some of it off before all the reducing reactions are complete. Resist the urge because a few minutes' hesitation can save you hundreds of dollars' worth of valuable elements.

Since the use of reducing slags generally lengthens furnace time and entails the consumption of relatively expensive furnace additions, it is best to avoid such slags whenever possible. Generally they are required only for certain special types of heats. It would not be desirable to encumber this discussion with long descriptions of the variety of different procedures for making the many types of highly alloyed steels where reducing slags are required.

In the case of stainless steels there is an excellent article by Crafts and Rassbach[6] which explains in detail how these are made. The manufacture of many alloy grades of steel is as much an art as a science. Guidance in the making of a specific type of alloy steel can usually be obtained from other operators, from consultants to the industry, and from technical representatives of the several companies supplying alloys.

Slags vs Lining Life. The character of basic slag can have a very marked effect upon the life of the furnace lining. When basic oxidizing slags become shiny they reflect the intense heat of the electrode arc back onto the roof and sidewalls of the furnace and it is possible to destroy an entire lining during the course of one heat. This type of slag has too great a content of iron oxide and not enough lime in it. It may be corrected quite easily by shoveling in burned lime. However, slags (especially in smaller furnaces) tend to get shiny so quickly that it is well to keep the slag under almost constant observation from the time the heat is melted until you tap.

Under reducing conditions certain slags which contain large amounts of calcium carbide can cause the arc to jump around the furnace and occasionally get too close to the sidewalls. Here again lining and roof life can be adversely affected. If your furnace practice requires that you operate with such a slag, there is little you can do about this except to use some special (and usually quite expensive) refractories which are more able to take the beating. Such slags are difficult to produce in a furnace and ordinarily this is not a problem which one falls into inadvertently.

This brings us to another very important rule of basic furnace operation: If the slag gets watery or shiny, add burned lime. Lime is the most important constituent of your basic slag and upon its presence depends virtually all the favorable characteristics of basic furnace melting. An acid heat gets its slag by erosion of the banks. A basic heat must have something specific, i.e., burned lime, added to it to make the slag.

Occasionally a basic slag may get so thick that the heat becomes difficult to work. This condition can be remedied by adding crushed iron ore or mill scale. Fluorspar may be used as a last resort, however, it is damaging to refractories and often its effects are only temporary. Fluorspar has three distinct uses:

1. Put it on top of the lime, underneath the electrodes when you are building a new slag. It will help melt this slag quickly.

2. Just before you tap, if your slag

happens to be a little thick, a small amount of fluorspar will thin it out long enough so that most of the slag will run out of the furnace when you tap.

3. When making low carbon steels judicious additions of fluorspar near the end of the carbon boil will enable you to keep the bath open (active) a little longer. A touch of fluorspar now and again can help things along; but it is best to adhere to the old open hearth rule: keep the heat open with ore, not spar. Your operation will be much smoother if you do.

If the bottom is in bad shape and is getting into the slag, the slag will become extremely gummy. This thickening is caused by the large magnesia content of such slags. It is next to impossible to shape up a slag like that. The best advice, if the condition starts to get out of hand, is to simply give up, get the heat out of the furnace and pig it if necessary. Make certain you drain the furnace completely; then do a good job of repairing the bottom and charge up again.

In summary, here are the points you should have in mind if you are contemplating converting your acid electric furnace to basic.

■ 1. Make certain that you have a definite dollars and cents gain through making basic rather than acid steel.

■ 2. If this is true, call on the various alloy and refractory companies to help you set up your proposed furnace lining and practice.

■ 3. If you still show a net gain after recalculating your estimated cost, be sure that your melters understand thoroughly the differences between acid refractories and basic refractories, acid slags and basic slags.

■ 4. Canvass literature and talk to basic electric furnace operators to supplement the information you have received from ferro-alloy and refractory manufacturers. Set down your furnace procedure and make certain that your melters and furnace helpers understand everything.

■ 5. Charge the furnace and make your first heat, being certain that:

(a) You have everything so well organized in your shop that you will not have any delays when you are ready to tap.

(b) You do not get your furnace too hot too soon.

(c) You keep slag basic and its volume within bounds.

(d) You do not allow the heat to die of its own accord—you are supposed to kill it with silicon or aluminum.

(e) If the slag gets shiny, add burned lime quickly.

Individual electric furnace practices, of necessity, must be extremely flexible so that the many different kinds of steels made with the many different kinds of raw materials in the many different kinds of furnaces can be produced economically and easily. The practices which you finally settle upon will evolve from your own experience and it would be folly to try to list hard and fast rules for making various grades of steel.

It may even be true that the best practices are those which change and improve year after year. In addition technical developments like the use of oxygen for making stainless steels may revolutionize a whole segment of the industry quite suddenly. Nevertheless, there are some fundamental concepts which may still have a long and useful life and it is hoped that this article has enumerated and explained some of these.

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Standardize Cupola Blast Fittings

■ Essential details of cupola air volumes, air inlet diameters, and flange drilling dimensions have been standardized by the Furnaces and Accessories Product Group of the Foundry Equipment Manufacturers' Association.

Committee on Cupola Standardization includes G. E. Seavoy, Whiting Corp., Harvey, Ill., chairman; H. W. Schwengel, Modern Equipment Co., Port Washington, Wis.; J. H. Gougler, Grindle Corp., also of Harvey; and C. McGlone, Whiting Corp.

The accompanying table of new standards can be met by blower and air weight control manufacturers.

Standardized Cupola Air Volumes and Inlet and Flange Dimensions

Cupola Size No.	Shell ID in.	Lining ID in.	Recommended Blower Capacity cfm at STP	Air Inlet in.-ID	Bolt Circle in.-Diam.	No. of Bolt Holes	Hole Diam. in.
1	32	23	1000–1050	10	$12\frac{1}{4}$	12	$\frac{11}{16}$
2	36	27	1430–1550	12	$14\frac{1}{4}$	12	$\frac{11}{16}$
$2\frac{1}{2}$	41	27	1430–1550	12	$14\frac{1}{4}$	12	$\frac{11}{16}$
3	46	32	2000–2400	14	$16\frac{1}{4}$	12	$\frac{11}{16}$
$3\frac{1}{2}$	51	37	2700–3000	14	$16\frac{1}{4}$	12	$\frac{11}{16}$
4	56	42	3450–3780	18	$21\frac{1}{4}$	16	$\frac{11}{16}$
5	63	45	4000–4500	18	$21\frac{1}{4}$	16	$\frac{11}{16}$
6	66	48	4500–5200	20	$23\frac{1}{8}$	20	$\frac{11}{16}$
7	72	54	5750–6875	20	$23\frac{1}{8}$	20	$\frac{11}{16}$
8	78	60	7100–8250	24	$27\frac{3}{4}$	20	$\frac{11}{16}$
9	84	66	8600–9700	24	$27\frac{3}{4}$	20	$\frac{11}{16}$
$9\frac{1}{2}$	90	72	10,200–11,340	24	$27\frac{3}{4}$	20	$\frac{11}{16}$
10	96	78	11,900–13,000	28	$31\frac{3}{4}$	28	$\frac{7}{8}$
11	102	78	11,900–13,000	28	$31\frac{3}{4}$	28	$\frac{7}{8}$
12	108	84	13,900–15,500	28	$31\frac{3}{4}$	28	$\frac{7}{8}$
13	114	90	16,100	30	$33\frac{3}{4}$	28	$\frac{7}{8}$
14	120	96	18,400	30	$33\frac{3}{4}$	28	$\frac{7}{8}$
Special installations sometimes require other standardized dimensions				6	$7\frac{7}{8}$	8	$\frac{9}{16}$
				8	10	8	$\frac{9}{16}$
				16	$19\frac{1}{4}$	16	$\frac{11}{16}$
				36	$39\frac{3}{4}$	32	$\frac{7}{8}$
				42	$45\frac{3}{4}$	36	$\frac{7}{8}$
				48	$51\frac{3}{4}$	44	$\frac{7}{8}$

WHY USE FORGED HOOKS?

Foundryman might take a hint from this crane manufacturer who switched from forged to cast hooks. Result: stronger hooks at lower cost

R. P. Fox/*Chief Engineer*
Clyde Iron Works, Inc.
Duluth, Minn.

■ Because the art of hand forging is disappearing, we decided to switch to cast alloy steel crane hooks. In addition to guaranteeing a source of supply, we found that the change gave us stronger hooks at lower cost, as well.

Adopted with the usual reluctance to deviate from a tried and proven product, the cast hooks now are being produced in capacities from 5 to 70 tons for use under strenuous shipping dock service.

In selecting the hook material, a high strength alloy casting with good yield characteristics was favored. A high strength casting of approximately the same size as the replaced forged hook provides a 100 per cent increase in safety factor. The extra reserve establishes unquestionable confidence in the conversion and represents a substantial improvement in product. The hook was redesigned for cast steel by straight engineering mathematical calculations.

After the hook was designed and cast, destructive testing showed that the hook was one and a half times stronger than design calculations had predicted. During tests, at yield point load, the hook opened up appreciably, thus assuring a visible overload warning before ultimate failure.

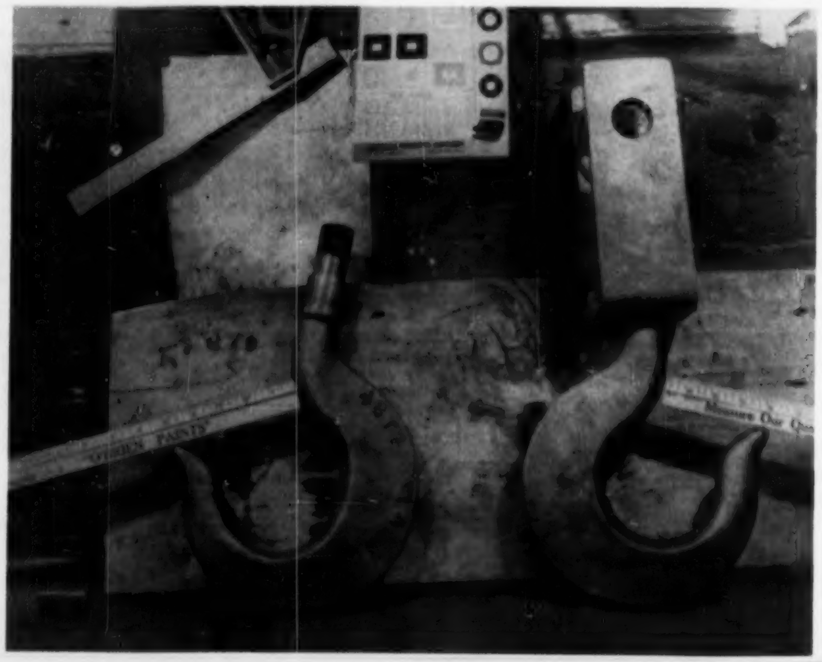
The steel selected for hooks has the characteristics given in the table. Quality of the steel is ultimately confirmed by hardness testing and magnetic particle inspection.

One of the award winners in the Steel Castings Users Div. of this year's Product Development Contest of the Steel Founders' Society of America.

Mechanical and Chemical Properties of Cast Steel Hooks

Carbon	0.30-0.40	per cent
Manganese	0.60-1.00	" "
Silicon	0.25-0.75	" "
Phosphorus	0.05 max	" "
Sulphur	0.05 max	" "
Chromium	0.60-0.90	" "
Molybdenum	0.40-0.50	" "
Tensile Strength	120,000	psi
Yield Strength	100,000	psi
Elongation	14	per cent
Reduction in Area	30	" "
Oil Quenched and Tempered	241-285	Bhn

Fifty-ton cast crane hook and shackle is used for strenuous shipping dock service. Others have capacities from 5-70 tons.



Visible overload warning before ultimate failure is seen in the open 5-ton cast hook that was stressed with yield point loads.

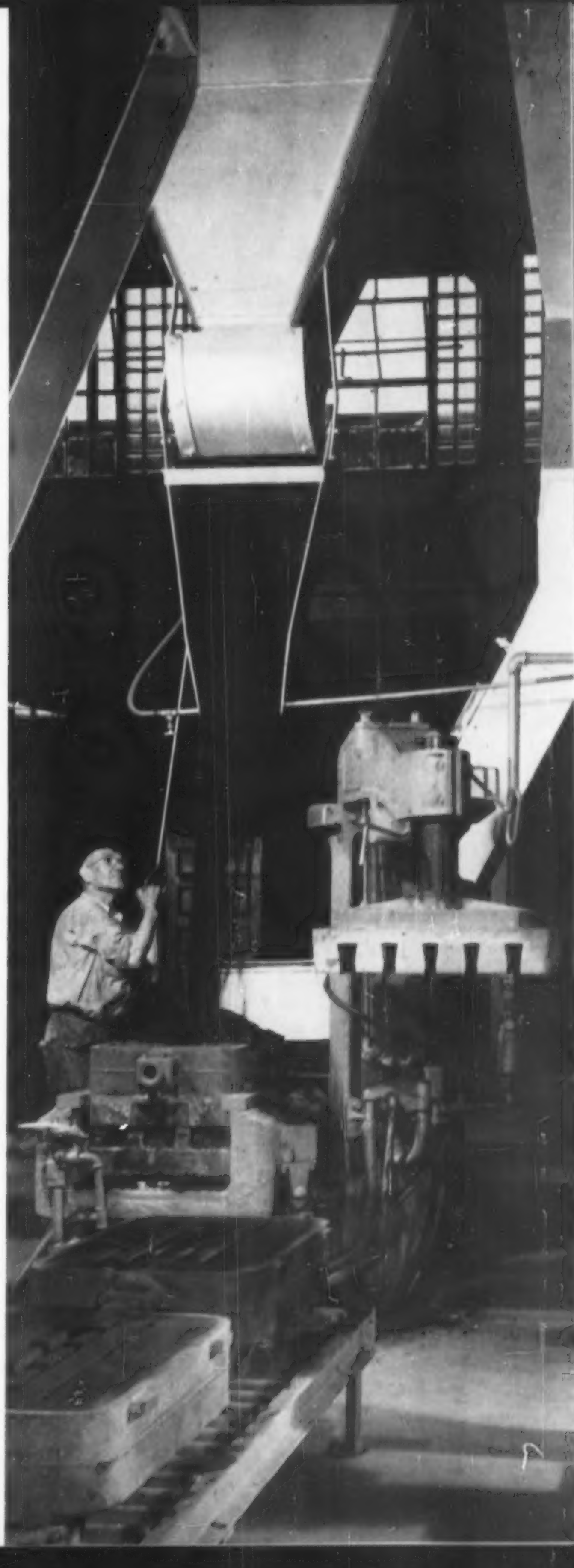
MOLDING

MATERIALS
METHODS
MACHINES

Tremendous increases in castings production have been made possible largely through improvements in the methods, equipment, and materials of molding. Here is a review of these advances and an evaluation of the processes

A MODERN CASTINGS BONUS

Condensed from the forthcoming AFS publication *Principles of Metal Casting*

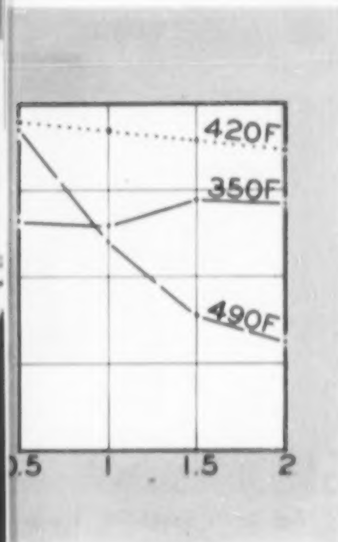


ORE BINDER

RLES J. GOGEK
Co., Argo, Ill.

ves

e gas



tures for different periods.

Mixture:

andard Sand		3000 gr
ereal Binder	1%	30 gr
extrose Binder	3%	90 gr
'ater	3%	90 ml

unded corn sugar syrup binder equally effective, as illustrated in ble 1.

Properties of Baked Cores. An ctrically heated oven fitted with circulating fan was used for king cores. As shown in Table 1 l Fig. 1, higher percentages of xtrose binder increased the ten- strength of baked specimen es. Baking time required to reach ak strength diminished as dex- se binder content increased. us, at an oven temperature of

Molds are the foundryman's forming tools . . .

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Dept. of Mining & Metallurgy

P. C. Rosenthal/*Chairman*
Dept. of Mining & Metallurgy
University of Wisconsin

■ The mold is the foundryman's forming tool. Good castings cannot be made without good molds. Because of the importance of the mold, casting processes and castings are often described by the materials and methods employed in molding. A classification of processes includes:

1. Sand casting
   - *a.* Green-sand molds
   - *b.* Dry-sand molds
   - *c.* Core-sand molds
   - *d.* Cement-bonded-sand molds
   - *e.* Loam molds
   - *f.* Shell molds
   - *g.* Pit and floor molds
2. Permanent-mold casting
3. Die casting
4. Centrifugal casting
5. Plaster-mold casting
6. Investment casting
7. Special processes; graphite molds, ceramic molds

Each of the processes listed above has a field of most appropriate application, certain advantages, and limitations.

Sand-molding processes are used to produce, by far, the largest quantity of castings. Whatever the metal poured into sand molds, the product may be called a "sand casting." There are a number of sand-molding processes used for different purposes.

Green-sand Molding is most common among the sand-casting processes. Green molding sand may be defined as a plastic mixture of sand grains, clay, water, and other materials. The sand is called "green" because of the moisture present and is thus distinguished from dry sand.

Basic steps in green-sand molding are:

1. *Preparation of the pattern.* Most green-sand molding is done with matchplate, or cope and drag patterns. Loose patterns are used when relatively few castings of a type are to be made. In simple, hand molding, the loose pattern is placed on a mold board and surrounded with a suitable-sized flask.

2. *Making the mold.* Molding involves ramming sand around the pattern. As the sand is packed, it develops strength and becomes rigid within the flask. Mechanical ramming is done with molding machines, considered in the next section. Ramming may also be done by hand. Both cope and drag are molded in the same way, but the cope must provide for the sprue. The gating-system parts of the mold cavity are simply channels for the entry of the molten metal.

3. *Core setting.* With cope and drag halves of the mold made and the pattern withdrawn, cores are set into the mold cavity to form the internal parts of the casting. The core-setting operation may be done by hand or mechanically.

4. *Closing and weighting.* With cores set, the cope and drag are closed. The cope must usually be weighted down or clamped to the drag to prevent it from floating when the casting is poured. Metallostatic pressure pushing up on the cope can cause the mold to separate at the parting and allow the metal to run out.

Advantages of green-sand molding and molding sands are:

1. Great flexibility as a production process—mechanical equipment can be utilized for performing molding and its allied operations. Furthermore, green sand can be reused many times by reconditioning it with water, clay, and other materials. The molding process can be rapid and repetitive.

2. Usually the most direct route from pattern to mold ready for pouring is by green-sand molding.

3. Economy—green-sand molding is ordinarily the least costly method of molding unless special reasons exist which favor the other casting processes.

Limitations in the use of green-sand molding are:

1. Some casting designs require the use of other casting processes. Thin, long projections of green sand in a mold cavity are washed away by the molten metal or may not even be moldable. Cooling fins on air-cooled-engine cylinder block and head are an example. Greater mold strength is then required.

2. Some castings develop defects if poured into molds containing moisture.

3. More intricate castings can be made by other casting processes.

4. The dimensional accuracy and surface finish of green-sand castings may not be adequate. A dimensionl variation of ±1/64 in. on small castings and ±1/16 to ±3/32 in. on larger ones may be encountered. However, this variation on many castings may be much less if adequate control is exercised.

5. Large castings require greater mold strength and resistance to erosion than exist in green sands.

Dry-sand Molds. Dry-sand molds are actually made with molding sand in the green condition. The sand mixture is modified somewhat to favor good strength and other properties after the mold is dried. Dry-sand molding may be done the same way as green-sand molding on smaller sizes of castings. Usually the mold-cavity surface is coated or sprayed with a mixture which upon drying imparts greater hardness or refractoriness to the mold. The entire mold is then dried in an oven at 300 to 650 F or by circulating heated air through the mold. The drying operation is one inherent disadvantage of dry-sand molding. However, because the mold is dry, the volume of gas formed when the casting is poured is much less than with green molds, and casting defects attributable to moisture should be absent.

Skin-dried Molds. The effect of a dry-sand mold may be partially obtained by drying the mold surface to some depth, ¼ to 1 in. Skin drying may be performed by torches, a bank of radiant-heating lamps, or electrical heating elements directed at the mold surface. Skin-dried molds must be poured shortly after drying so that mois-

Use core molds for intricate castings . . .

ture from the undried sand will not penetrate the dried skin.

Floor and Pit Molding. The production of large intricate castings weighing from 1 to over 100 tons is, of course, one of the special advantages of the sand-casting processes. Consider how difficult it would be to make large intricate shapes in some other way. The surface finish and dimensional accuracy of large castings in ferrous alloys is not that of smaller ones, dimensional tolerances of $\pm 1/16$ to $\pm \frac{1}{4}$ in. being acceptable unless special experience permits closer control. The problems of mold construction, handling, coring, gating, pouring, and cleaning of large castings require much engineering effort and control. The terrific amount of labor, time, and materials going into making a large casting makes the scrapping of one exceedingly costly.

MOSTLY HAND WORK

When molds are medium to large in size, considerable heavy equipment, floor space, and time must be allocated to the molding operation. Floor molding is done on the floor of bays of the foundry set aside for these heavy molding jobs.

When the pattern being molded is too large to be handled in flasks, molding is done in pits. Molding pits are concrete-lined, box-shaped holes in the molding floor. The pattern is lowered into the pit and molding sand is tucked and rammed under the pattern and up the side walls to the parting surface. The cope of the pit mold is finished off with cores or with sand rammed in a cope flask. Such large molds are always dried.

LOAM MOLDING

When a large mold for a gray-iron casting can be constructed in multiple-piece flasks or by bricking up a large portion of the mold, loam is used as the molding material. Loam is a molding sand containing about 50 per cent sand grains and 50 per cent clay. It is troweled onto a brickwork surface and brought to the pattern dimensions by using skeleton patterns, sweeps, or templates as the molding progresses. Loam molds must also be thoroughly dried. Very few foundries are equipped to do loam molding.

Cement-bonded-sand Molds. Cement-bonded molding sand is a mixture of sand, 8 to 12 per cent high-early-strength hydraulic cement, and 4 to 6 per cent water. This mixture develops great hardness and strength when the cement sets. Molding may be performed by the methods discussed above and others specially suited to the cement. The mold must be allowed to harden before the pattern can be withdrawn. Then the mold is allowed to cure or continue setting for about 72 hr before the mold can be closed or assembled for pouring. When the mold is poured, heat causes the water of crystallization of the cement to be driven off, and thus steam must be allowed to pass off through the sand by means of its porosity and suitably distributed vent holes. Cement-bonded-sand molds can be constructed with considerable accuracy, often more than that obtainable in other processes for making large molds. Consequently more accurate castings may be obtained.

Core Sand or Core Molds. Sometimes molds are made entirely of an assemblage of cores. In place of patterns, core boxes are used for making all parts of the mold. The cores are fitted together to make the mold, being located by alignment bosses and holes. They usually are poured without a flask surrounding the mold.

ORGANIC BINDERS

Core molds usually consist of mixtures of sand grains and organic binders which develop great strength after baking at 300 to 450 F. This strength makes it possible to cast metal around thin sand projections without having them break or erode when being poured. Core-sand binders and the baking operation plus difficulties in reusing the sand make the process more costly. However, this is usually justified in the intricate castings made by this process.

Core-sand molds are also sometimes made with dry molding sands or cement-bonded sands where the great strength and heat resistance of a dry-sand mixture is required, as in large castings.

Shell Molding (C Process). Shell molding is a newcomer among the molding processes for making sand castings. It was invented by Croning of Germany during World War II.

High production molding with sand, mold, and flask handling systems usually uses rugged, tight flasks on cope and drag mounted patterns.

Special techniques make precise castings . . .

The sand used for shell molding consists of a mixture of the following ingredients:

1. Dry-sand grains, AFS fineness 90 to 140 distributed over 4 to 5 screens.

2. Synthetic-resin binder, 3 to 10 per cent by weight. Resins which may be used are the phenolformaldehydes, urea formaldehydes, alkyds, and polyesters. The resin must be a thermosetting plastic since the strength developed by the mold depends entirely on the strength of the plastic binder after the mold has been heated.

SHELL CURING TECHNIQUE

The shell is cured in two stages. When the sand mixture drops onto a pattern heated to about 350 to 700 F, the plastic partially thermosets and builds up a coherent sand shell next to the pattern. The thickness of this shell is related to pattern temperature, dwell time on the pattern, and the sand mixture. An example of these relationships is:

Pattern-plate temp	*Approx time, for 3/16-in. shell, 6% resin sand*
300 F	21 sec
350 F	12 sec
400 F	10 sec
450 F	7 sec

The shell, still on the pattern, can then be cured by heating it to 550 to 650 F for 1 to 3 min. Stripping the shell from the mold presents a problem since the shell is very strong and grips the mold tightly. A mold-release agent or parting agent is necessary so that the ejector pins can push the shell off the patterns. Silicone parting solutions sprayed on the pattern have been found satisfactory. The shell halves may then be assembled and poured.

Advantages claimed for shell molding are exceptionally good surface finish and dimensional accuracy, 0.003 to 0.010 in. per in. variation being obtained in some castings. Hence the elimination of some machining operations, decreased casting-weight variation, and less cleaning cost are available. However, the process is still so new that its exact place has not been established.

Molds which can be reused many times are made of metal, usually gray cast iron or steel, though sometimes of bronze. The mold cavity (or die cavity) in a permanent mold is often cast to its rough contour and then is machined to its finished dimensions. The gating system as well as mold cavities are machined. The machined mold makes it possible to obtain very good finish and dimensional accuracy in the castings. Aluminum, magnesium, zinc, lead, copper-base alloys, and cast irons are the principal alloys so cast. Extremely high temperatures of casting and consequent mold attrition make permanent molds unsuitable for most steel castings. Pouring temperatures, approximate mold life, and mold operating temperatures are as follows:

Metal	Pouring-temp range, F	Approx mold life	Mold operating temp, F
Gray cast iron	2300-2700	5,000-20,000 castings	600-800
Aluminum base	1300-1400	Up to 100,000 castings	650-800
Copper base	1900-2100	5,000-20,000 castings	250-500
Magnesium base	1200-1300	20,000-100,000 castings	300-600
Zinc base	730-800	100,000 + castings	400-500

The process is limited to volume production and usually requires a continuous cycle of mold preparation, pouring, and casting ejection. This is necessary so that all steps can be timed and the mold then kept within a fixed operating-temperature range at the start of the pour. Operating temperature of the mold is one of the most important factors in successful permanent-mold casting. Automatic machines have been developed to obtain a continuous cycle.

MOLD COATINGS

Mold life is extended and casting ejection made easier by coating the mold cavity. Carbon soot, deposited from an acetylene torch, is used for iron castings. Refractories suspended in liquids may be sprayed on the cavity. The coating can be used for controlling the rate of heat extraction from the casting by varying its thickness. Metal or sand cores may be set in the mold before it is closed. The metal is usually fed into the mold only by gravity (gravity casting), but in some cases air pressure, 3 to 10 psi, is used on the sprue after the casting is poured.

By means of permanent mold casting, dimensional tolerances of ±0.010 in. on a dimension for many castings together with good surface finish can be obtained. The chilling action of the mold produces better metal properties in many alloys. Holes can be cored and inserts cast into place more accurately than is possible in sand molds. The casting design, though, must be simple enough and with sufficient draft so that ejection from the mold is feasible. Because of mold cost, the process is limited to applications where the advantages named result in an economic or engineering gain in preference to sand castngs. Castings in this category include carburetor bodies, refrigeration castings, hydraulic-brake cylinders, connecting rods, washing-machine gears and gear covers, oil-pump bodies, typewriter segments, vacuum-pump cylinders, small crankshafts, flatiron bases, and valve bodies.

DIE CASTING

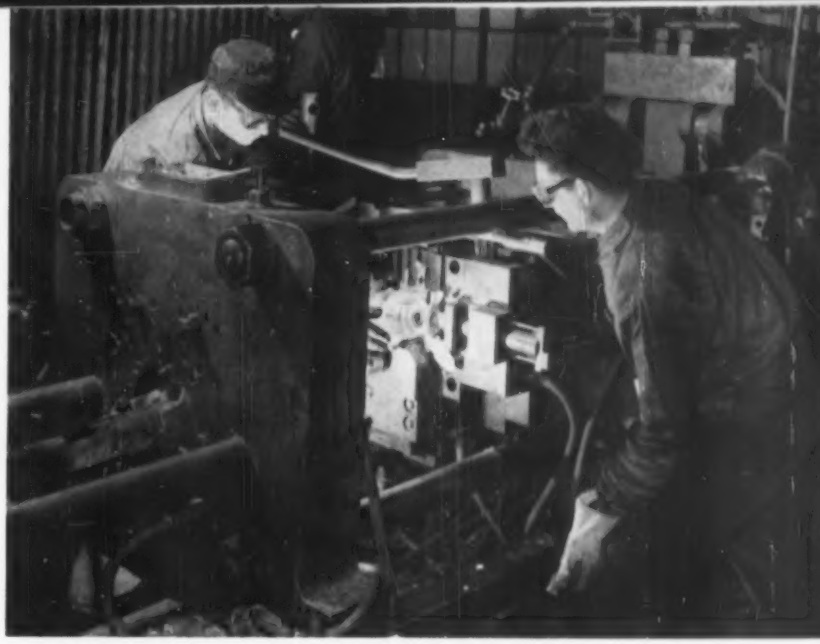
Die casting differs from permanent-mold casting in that the molten metal is forced into the mold cavity under high pressures, 1000 to 100,000 psi. Two principal types of die-casting machines are used, the hot-chamber and cold-chamber machines. Molten metal flows into the hot chamber since it is submerged in the melt and is then forced into the die cavity at 1000 to 2000 psi. In the cold-chamber process, metal is ladled into the shot chamber. Pressures in the cold-chamber machine may go as high as 30,000 psi. The first-named machine is used for casting zinc, tin, lead, and other low-melting alloys. The last-named one is used for casting aluminum, magnesium, copper-base, and other high-melting alloys. Ferrous alloys are not

yet die-cast because of their high pouring temperatures. Die-casting temperatures are similar to those used for permanent-mold castings given in the previous section.

Die casting as a production casting process has certain advantages, some of which are listed below:

1. A production rate of 150 to 250 die-cast cycles per hour with up to 500 shots per hour possible.
2. Commercial dimensional tolerances of +0.001 to +0.003 in. can be obtained easily in some castings.
3. Thin sections, down to 0.015 in. in small castings, can be cast because of the pressures involved.
4. Accurate coring and casting of inserts is possible.
5. Surface finish of many castings is such that they can be buffed directly.
6. Rapid cooling rate produces high strength and quality in many alloys; zinc-base die-casting alloys, for example, would not be used in many of their present applications if they could only be sand-cast.

On the other hand, the casting design must be such that the mold cavity and cores allow the casting to be ejected. This is a fundamental difference or limitation of metal molds, however cast, not applying to sand-casting processes.



Cold-chamber die casting of one-ounce to 20-lb parts, 0.015 to 0.150 in. thick, is practical when large quantities are required.

INVESTMENT CASTING

Investment casting is a process also known as the "lost-wax" process, or "precision" casting. The term "investment" refers to a cloak or special covering apparel, in this case a refractory mold, surrounding a refractory-covered wax pattern. In this process a wax pattern must be made for every casting and gating system to be cast; i.e., 10,000 castings require 10,000 patterns. The patterns are cast by injection molding. The wax pattern is in effect die-cast in metal molds. To obtain the wax pattern it is necessary to have a master metal pattern from which the die can be cast using low-melting alloys, or the die itself may be machined as a negative of the pattern. Starting with the pattern, the steps in the process are as follows:

1. A master pattern and die for casting the wax patterns is made. The die usually a tin-bismuth alloy, must have allowance for shrinkage of both wax and later the metal casting, about 0.011 to 0.015 in. per in. total.

2. Wax patterns and gating systems are produced from the metal dies. Waxes employed are blends of beeswax, carnauba, ceresin, Acrawax, paraffin, and other resins usually obtained as proprietary mixtures. The wax is injected into the mold at 150 to 170 F and at a pressure of 500 to 1000 psi. Polystyrene plastics are also used but require a mold temperature of 300 to 600 F, pressure up to 12,000 psi, and iron or steel dies. Mercury may also be used in place of wax patterns but must be frozen to retain the shape desired. Patterns and gating system must be assembled if cast separately. They can be joined by heating the surfaces to be attached in the case of wax or moistening them with a solvent, carbon tetrachloride, in the case of polystyrene patterns.

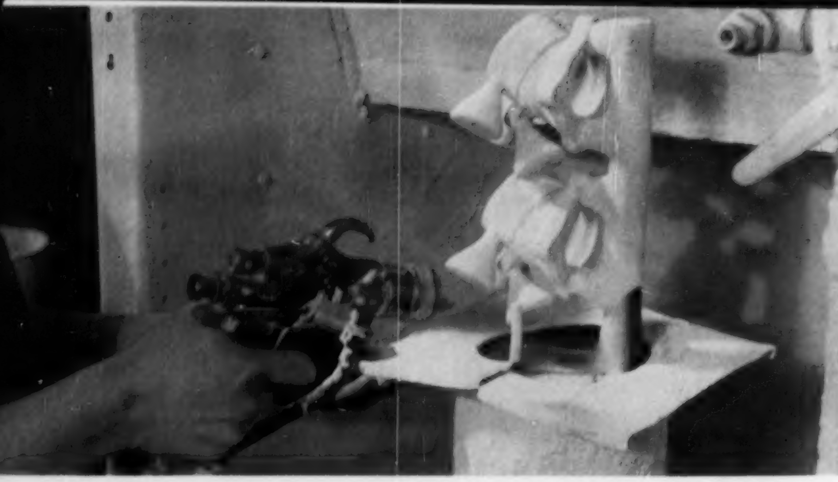
3. Precoating. The wax assembly is dipped into a slurry of a refractory coating material. A typical slurry consists of 325-mesh silica flour suspended in water-ethyl silicate solution of suitable viscosity to produce a uniform coating after drying. Some typical coating materials are listed in Table [illegible] dipping, the [illegible] dry up to 10 [illegible] coating is not [illegible] the wax pattern is directly invested in the molding material. In this case, the molding mixture must be vacuumed to remove air bubbles which may lodge next to the pattern.

4. The coated wax assembly is next invested in the mold. This is done by investing the wax assembly on a table, surrounding it with a paper-lined steel flask and pouring the investment-molding mixture around the pattern. The mold material settles by gravity and completely surrounds the pattern as the work table is vibrated.

INVESTMENT MATERIALS

The molding investment is composed of silica or quartz grains and binders. Two types of investments are used, one for low-temperature metals cast below 2000 F and others for metals with high pouring temperature. These of course are related to the precoating listed in the table above. Some typical investment-molding mixtures are given in Tables 1 and 2. The molds are allowed to air-set for 6 to 8 hr.

5. Dewaxing and preheating. Wax is melted out of the hardened mold by heating it in an inverted position at 200 to 300 F [illegible] may be [illegible] patterns in [illegible] preferably dried at 140 to 160 F. For burnout and preheating, the molds are heated at the rate of 100 to 160 F per hr



Spraying silica on sprue-base areas of investment molding wax pattern assembly which were not covered in the dipping operation.

Spun molds may be vertical or horizontal, and on axis or off.

from about 300 to 1600 to 1900 F for ferrous alloys or 1200 F for aluminum alloys. The finishing temperature of preheating is controlled so that the mold is at a temperature desirable for pouring the particular alloy and casting design. Burnout and preheating cycle must completely eliminate wax and gas-forming material from the mold.

6. Pouring. In the case of ferrous castings the mold is poured with metal from an individual small melting furnace, arc type, holding the exact weight required by the mold. When the mold is at pouring temperature the furnace and mold are inverted, transferring metal from the former to the latter. Air pressure may then be applied to the sprue to force-fill the mold cavity.

7. Cleaning operations follow low cooling of the casting.

Certain advantages characteristic of the precision-casting process are listed below:

1. Casting high-pouring temperature alloys to accurate dimensions. The metallic-mold processes are not suitable for steel and other alloys which must be poured at high temperature. Accuracy of ±0.003 in. per. in. is possible in many castings. Machining on castings of many difficult-to-machine alloys is reduced or eliminated. Elimination of machining is one of the great virtues of the process.

2. Castings of great exterior and interior intricacy may be cast.

3. Thin sections may be cast, even in the high-pouring-temperature alloys, because of the heated molds. Wire forms down to 0.002 in. in diameter and 2 in. long have been cast.

At present most casting sizes by this process run up to 5 lb in weight, although much larger ones have been cast. Of course, the economic factors of casting by the various processes, and possible savings through precision casting are important ones in deciding whether the process shall be used.

Casting in plaster molds, or plaster-bonded molds, has become a useful casting process. Copper- and aluminum-base alloys may be cast in plaster molds, but ferrous alloys are not. Plasters used for molding consist of mixtures of gypsum or plaster of paris ($CaSO_4 \cdot \frac{1}{2}\ H_2O$ and ingredients such as talc, asbestos fiber, silica flour, and others to control the contraction characteristics of the mold and setting time. The plaster is added to water and mixed to a consistency of 140:180. Consistency is defined as the pound

Table 1 . . Precoating and Investment Formulas*

Formula	Ingredient	%
No. 1	Plaster of paris	30.0
	Silex (powdered)	70.0
No. 2	Plaster of paris	52.0
	Marble dust	16.0
	Graphite	16.0
	Soapstone (powdered)	16.0
No. 3	Plaster of paris	50.0
	Powdered mica	25.0
	Marbe dust	25.0
No. 4	Alpha gypsum (21)	30.0
	Silica (200-400 mesh)	62.0
	Andalusite (fine)	5.0
	Alundum (fine)	1.0
	Boric acid	2.0
No. 5	Plaster of paris	30.0
	Cristobalite	50.0
	Tridymite (and silica)	20.0
No. 6	Calcined gypsum	30.0
	Silica	69.0
	Strontium chloride	1.0
No. 7	Calcined gypsum	80.0
	Asbestos fiber	20.0
No. 8	Plaster of paris	60.0
	Silica	25.0
	Talc	15.0
No. 9	Silica	67.0
	(Tetraethyl silicate, 8 vol.)	
	(Water, 1 vol.)	
	Liquid	33.0
	(Alcohol, 1-2 vol.)	
	(Hydrochloric acid, few drops)	
No. 10	Silica	90.0
	Magnesia	6.0
	Monobasic ammonium phosphate	3.0
	Monobasic sodium phosphate	1.0
	Liquid—water or 10% hydrochloric or nitric acid	
No. 11	Solids (187 parts)	94 parts 325-mesh silica; 56 parts 325-mesh alumina; 37 parts 40-mesh sand
	Liquids (80 parts)	4 parts 20 Be sodium silicate; 1 part 2% polyvinyl alcohol

*From K. Geist and R. M. Kerr, Jr.

Numbers of above formulas refer to type as follows:

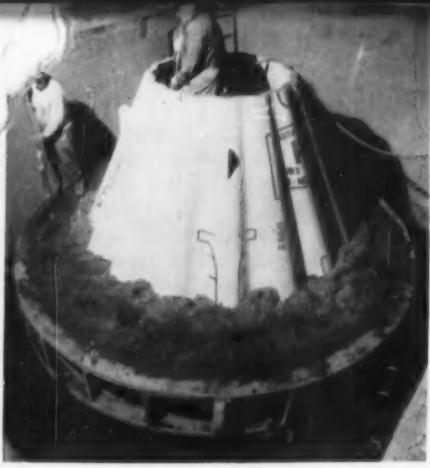
Formulas 1 to 3 are old types of dental investment of low expansion.

Formulas 4 to 6 are new types of dental investment of high expansion.

Formulas 7 and 8 are mixtures for plaster casting.

Formulas 9 and 10 are investments for stainless high-fusing alloys.

Formula 11 refers to heat-resistant alloys.



Ramming green sand core over perforated hollow steel arbor.

Simplest set-up for speeding-up molding for small castings.

of water per 100 lb of plaster in the mixture.

Dry strength of the plaster depends greatly on the consistency of the mix, as revealed in the following table from R. F. Dalton:

Dry compression strength, psi	*Consistency lb water/100 lb mix*
11,000	30
6,000	37
4,000	47
2,000	68 (usual for plaster of paris)
200	140-180

After mixing, the plaster in a creamy condition is poured over the pattern and retained in a flask. A pattern parting, stearic acid dissolved in petroleum spirits, for example, may be used. Generally metal patterns are necessary because the water in the plaster raises the grain on wood patterns and makes them almost impossible to draw. After setting 20 to 30 min, the pattern can be rapped and blown off the mold by air.

Permeable (porous) casting plaster can be made by beating air bubbles into the plaster slurry with a mechanical mixer. Permeabilities up to 130 in standard permeability tests are possible.

Setting of the plaster involves hydration of the gypsum: $CaSO_4 \cdot \frac{1}{2} + 3/2\ H_2O = CaSO_4 \cdot 2H_2O + \text{heat}$. After setting, the molds are dried at 400 F or higher. For aluminum castings, 10 to 20 hr at 400 F is suitable. The plaster can be partially dehydrated at higher drying temperature, and consequently the mold evolves less steam when the castings are poured. However, mold strength is lost with dehydration. It is obvious that the time required for curing plaster molds is an undesirable part of this process. However, because of dimensional accuracy and surface finish, many castings, such as rubber-tire molds, foam-rubber molds, cast match plates, and the like are molded in this way.

Table 2 . . Investment-molding Mixtures*

No.	Refractory total, % †	Type sand ratio‡ Lake	Albany	Juniata	Binder	Water, %
1	95	1	1	1	5% alumina cement	27.9
2	95	1	1	2	5% alumina cement	30.9
3	91.2	1	1	2	6.5% primary ammonium phosphate, 2.30% MgO, 300 mesh	33.8
4	90.6	1	1	2	7.1% primary calcium phosphate, 2.30% fused MgO, 300 mesh	51
5	92.3	1	1	1	5.17 primary ammonium phosphate	34.1
6	80	8	1	1	5% alumina cement	105
7	....		Sand		Ethyl silicate or sodium silicate	

*From W. F. Davenport and A. Strott.
† % of total dry ingredients.
‡ The sand type and grain distribution are very important and are therefore appended in Table 2a.

Antioch Process. Molding in the Antioch process, developed by Morris Bean, is done with a mixture of sand, gypsum, asbestos, talc, sodium silicate, and water, sand being the bulk ingredient and gypsum the binder. In proportions of 50 parts water to 100 parts dry ingredients, water is added to dry material consisting of 50 per cent silica sand, 40 per cent gypsum cement, 8 per cent talc, and small amounts of sodium silicate, portland cement, and magnesium oxide. This slurry is poured around the pattern in suitable flasks or metal core boxes and in about 7 min develops a set strength of about 70 psi in compression. After standing about 6 hr, the molds are assembled and autoclaved in steam at about 2 atm pressure. They then are dried in air for about 12 hr and finally in an oven for 12 to 20 hr at 450 F. The autoclaving and drying process produces permeability, about 25 to 50 AFS permeability. The molds are then ready to be poured.

Table 2a . . Sand Analysis* †

U.S. Series sieves	Sand Lake	Albany	Juniata
On 20			
—20 + 30	0.3	0.1	
—30 + 40	5.0	0.6	0.1
—40 + 50	49.4	2.9	2.5
—50 + 70	36.0	10.6	5.7
—70 + 100	8.9	39.2	21.8
—100 + 140	0.5	18.1	13.8
—140 + 200	0.1	19.7	20.9
—200 + 270	....	5.5	19.0
—270 + 325	....	1.5	3.8
—325	....	1.8	12.4

* From Eaton Manufacturing Co.
† Sand sieve analysis for sands in Table 2.

ADVANTAGES OF PLASTER

The advantages of plaster molds are that nonferrous castings can be made with good surface finish and dimensional accuracy. Tolerances of ±0.005 in. on small castings and ±0.015 in. on large castings such as rubber-tire molds can be obtained. Metallurgical quality in aluminum castings is also claimed for the Antioch process, because metal chills can be embodied in the mold. Hydraulic torque-converter elements of hydraulic automobile transmissions are an example of the intricacy and accuracy attainable.

Mold materials govern heat flow . . .

Centrifugal casting refers more specifically to the forces used to distribute the metal in the mold than to a specific molding process. However, since molds for centrifugal casting are usually specially designed, it is considered as a special process. Centrifugal casting falls into three categories:

1. True centrifugal casting
2. Semi-centrifugal casting
3. Centrifuging

Either permanent molds or sand-lined tubular flasks are used. Sometimes core-sand molds are centrifugally cast. Short castings may be cast with the spinning axis vertical. Centrifuging differs from the previous two in that the entire mold cavity is spun off the axis of rotation. Metal is fed from a central sprue through a gate into the mold cavity. Pipe, gun tubes, bushings, and a variety of centrifugal castings are made by this process.

SPECIAL PROCESSES

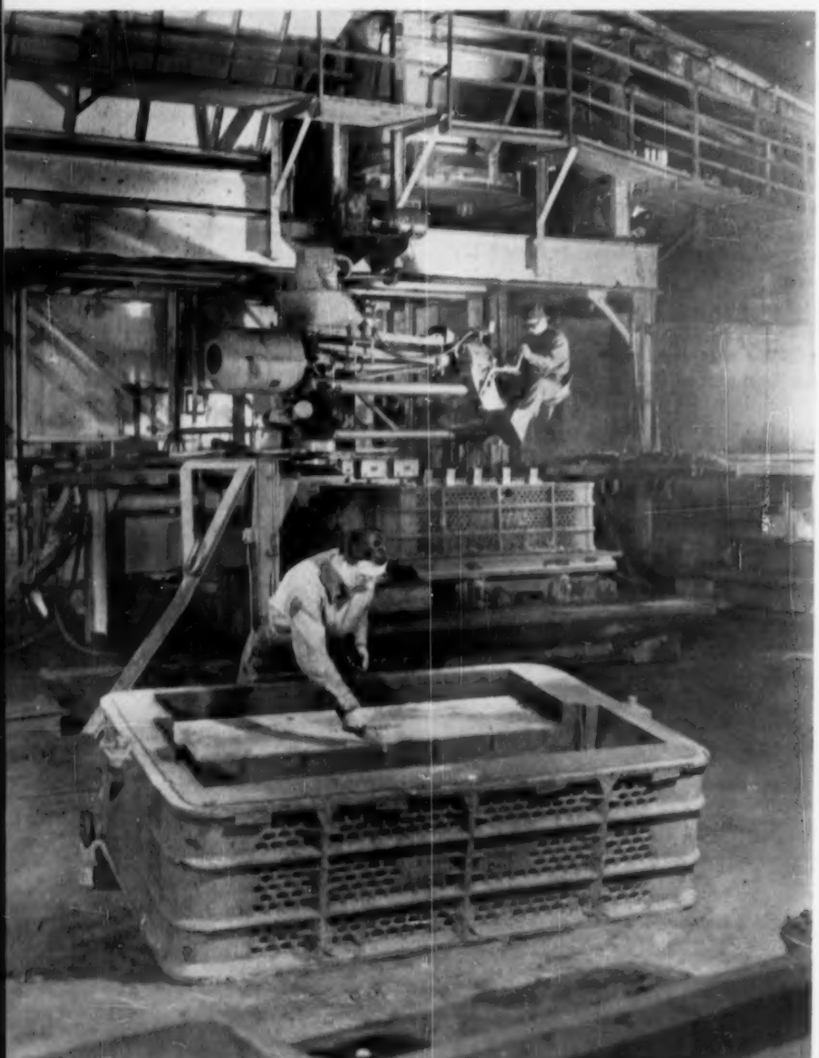
In addition to the more common molding processes described earlier, there are a few less frequently used methods and materials for molding.

Graphite Molds. Graphite may be used as a mold for casting nonferrous alloys and cast irons. Blocks of graphite may have mold cavities machined into them, as is done with permanent metal molds. These molds have advantages like those of metal molds except that they are not so durable. Graphite begins to oxidize above 750 F and the mold then begins to show wear. A mold coating of ethyl silicate which deposits silica on heating increases the number of castings which may be made before the mold is unsatisfactory. Graphite mold liners are used considerably in centrifugally casting brass and bronze bushings, sleeves, and other shapes. They may also be used for limited runs of permanent-mold-type castings. Recently railroad-car wheels have been cast in graphite molds so accurately that no machining is required.

Other Materials. Aluminum is used to a limited extent as a mold material for low-temperature casting alloys. The mold can be cast to shape sufficiently accurately so that only a small amount of machine work is necessary to finish the mold cavity. By anodizing the mold cavity, it is given added heat resistance. The ability of aluminum to extract heat rapidly has made it possible to pour even ferrous castings in these molds. However, their main use appears to be for casting low-melting alloys in permanent molds.

Silicon carbide is the mold material in a process used for making permanent molds without the need for machining each mold. Granular silicon carbide is mixed with bentonite (clay) and water containing sodium carbonate. This mixture is plastic and may be molded like a green molding sand. After the mold is made, it is fired at about 1500 F and is thus converted into a stable, hard mold. This mold has chilling power much greater than that of sand though not so great as metal. The process is a British invention, and its use is not known in this country as yet.

Operator, riding a stationary sand slinger, rams-up a large cope while finisher repairs the drag half of a diesel cylinder block.



CHARACTERISTICS OF MOLD MATERIALS

The quality of castings depends on a multitude of interdependent variables. Certain of these factors are quite evidently due to the nature of the metal of which the castings are made. Others are due to the nature of the mold, the mold material, molding process, and method of casting. One of the inherent characteristics of the mold which influences casting quality is

considered in the following paragraphs.

Heat Removal. The mass of the casting and its heat content determine the amount of heat in Btu which must be removed to cool the casting to room temperature. The surface area of the casting, fundamentally its design, determines the mold-cavity area through which the heat must be extracted. However, the mold largely determines the rate at which the heat may be extracted. Its thermal conductivity, heat capacity, and characteristics such as size, shape, and means of cooling regulate the time required for the molten metal to solidify and the solidified casting to cool to room temperature.

THERMAL CONDUCTIVITY

The thermal conductivity of a number of mold materials is compared in Table 3. Table 3 shows that molding sands and plaster are least able to extract heat. Of course, the particle size and denseness of packing of aggregates have a great influence on conductivity. For example, silica brick having a higher density than molding sand has better conductivity. This is also illustrated in a comparison of the conductivities of flake graphite and graphite brick (Table 3). Green molding sand appears to be able to extract heat more rapidly than dry sand. However, this situation changes as soon as the green sand is heated above 212 F.

A fundamental difference in the chilling power of metal molds as compared with sand molds is revealed by Table 3, the difference being on the order of 1000- to 10,000-fold. This fact is the reason for a number of metallurgical differences in the properties of alloys when they are cast in the two different types of mold materials. Grain size, segregation, alteration of the microstructure, changes in response to heat-treatment, and other metallurgical properties of casting alloys are affected by differences in cooling rate. For example, a cast iron can be either a gray or a white iron depending on its rate of solidification. Many other instances could be cited.

At this point it should be recognized that the thermal conductivity of the mold material does very substantially affect metallurgical casting quality. Because of these differences in thermal conductivity of molding materials, different materials may be used in the same molds to produce temperature gradients. Chills are metal forms put into sand or plaster molds to extract heat rapidly from certain parts of a casting. Insulation may be used on risers which are supposed to remain molten longer than the casting in order to feed liquid metal into the mold cavity during solidification. An intelligent use of mold materials can make it possible to produce temperature gradients and rates of heat extraction which will favor the highest metallurgical quality.

Table 3 . . Approximate Thermal Conductivity of Various Materials*
Btu/hr/sq ft/F difference/in. thickness

Material	Thermal conductivity						Source
	R.T.	200 F	400 F	1000 F	1600 F	2000 F	
Dry sand	....	0.133	0.169	0.300	......	0.600	*b*
Tempered (wet) sand	....	0.672	....	....	......	....	*b*
Charcoal	0.36	....	....	....	......	....	*d*
Powdered gypsum	0.60	....	....	....	......	....	*d*
Plaster of paris	2	....	....	....	......	....	*d*
Silica brick	6.0	6.8	8.3	9.8	12.0	13.5	*a*
Magnesite (fired)	39.6	36.4	33.5	30.7	26.3	21.9	*a*
Carborundum brick (SiC)	87	....	....	....	......	....	*d*
Carbon, graphite	165	....	....	....	......	....	*c*
Gray cast iron	325	....	....	280	......	....	*c*
0.41% C steel	360	....	335	265	......	....	*c*
Graphite brick	695	....	....	....	......	....	*d*
Aluminum	1540	....	....	....	......	....	*c*
Copper	2730	....	....	....	......	....	*c*
Diatomaceous earth	0.31	....	....	....	......	....	*d*
Asbestos paper	1.70						

*Taken from the following sources:
a. Harbison-Walker Refractories Co., *Modern Refractory Practice*, 1950.
b. Paschkis, V., "Heat Flow in Most Sand," *Transactions, American Foundrymen's Society*, 1952 p. 163.
c. American Society for Metals, *Metals Handbook*, 1948.
d. Chemical Rubber Publishing Co., *Handbook of Chemistry and Physics*, 34th ed., 1952-1953.

PRODUCTION MOLDING

The tremendous increase in castings production has been made possible largely through improvements in the methods, equipment, and materials of molding. Sand molding is done in the following ways:

1. Bench molding
2. Machine molding
3. Shell molding
4. Floor and pit molding

Bench molding is hand work, small in size, and limited to the production of only a few molds hourly. Today it remains as the simplest way to make one or a few small castings of a kind. Floor and pit molding, are suited for the larger casting sizes. By far the largest tonnage of castings weighing up to several thousand pounds are produced by machine molding using green sand as the mold material.

MOLDING MACHINES

There are about 5200 foundries in the United States making sand castings. Except for highly specialized equipment their molding machines are of the following types:

1. Simple squeezers, hand- or air-pressure-actuated
2. Simple jolt machines, air-pressure-actuated
3. Jolt squeezer
4. Jolt-squeeze stripper
5. Jolt stripper
6. Jolt, rockover, draw
7. Jolt, squeeze, rollover, draw
8. Sand slinger
9. Variations of the above
10. Mold or core blower

Simple Squeezers. Squeeze-molding machines utilize pressure as a means of packing the mold. Pressure, applied pneumatically or manually through a squeeze head or plate, pushes the sand against the pattern. The squeeze is limited to light work which can be made in shallow flasks, preferably 2 to 4 in. in depth. The maximum squeezing force of a pneumatically operated squeeze-type machine is de-

fined by the following equation:

$$M.F. = P \times \pi d_c^2 - W \quad (1)$$

where $M.F.$ = molding force, lb

P = air pressure in the squeeze cylinder, psi; often assumed to be the air-line pressure

d_c = piston diam of the squeeze cylinder, in.

W = weight of pattern, flask, sand, and other accessories on the work table of the machine

Hence, the molding force of a squeeze machine is limited by its piston diameter and the air pressure available.

The molding force of the squeeze head is, however, distributed over the entire squeezing area at the top of the flask. While $M.F.$ is relatively constant for a particular machine (and air pressure), the flask size is not. Therefore, molding pressure applied at the flask surface is a better criterion of the packing force applied to the sand. This is determined by the following equation:

$$M.P. = \frac{M.F.}{A_f} \quad (2)$$

where $M.P.$ = molding pressure, psi, at flask surface

$M.F.$ = molding force, lb, applied by squeeze cylinder

A_f = surface area of flask under $M.F.$, sq in.

Molding pressures of 20 to 50 psi are in common use. A summary of the relations between squeeze piston diameter, line pressure, flask area, and actual molding pressure is given in Table 4.

SAND PACKING FORCES

Formulas (1) and (2) define the packing forces and pressures applied to the squeezed surface. If molding sand were a perfect fluid these pressures would be transmitted to the pattern surface and uniformly distributed. However, since molding sand behaves as a plastic aggregate of solid particles, much of the energy applied in moving the sand at the top surface of the flask is absorbed as friction and only a portion is transferred to the sand adjacent to the pattern. Bridging and keying of the sand grains against the flask and each other keep the molding pressure from reaching the pattern surface.

Thus it can be seen that molding by squeezing alone will become less effective for a given pressure as the depth of the mold half increases. Furthermore, there will be a differential in the degree of packing from the squeeze head to the pattern. Sand density is at a minimum adjacent to the pattern, and the hardness of the mold is therefore less than that next to the squeeze head. Because of nonuniform pressure distributions, the sand adjacent to the pattern may be nonuniformly rammed. There is therefore a limit to flask depth which may be properly molded by squeezing which is dependent on the squeeze-machine capacity, pattern contour, molding sand, etc. To obtain more uniform packing next to the pattern, the squeeze method of molding is used in combination with the jolt method.

Simple Jolt Machine work table with pattern, flask, and sand is raised by a pneumatically operated piston and allowed to fall against the base of the machine under the influence of gravity. Packing of the molding sand is caused by work done by the kinetic energy of the falling sand. Of course, the number of times that jolting is done will have a great effect on the degree of sand packing.

JOLT RAMMING

Note that, in this type of sand packing, the maximum molding force is applied at the pattern surface. The mold would thus be hardest at the mold-cavity face. Again, if sand were a perfect fluid it would flow uniformly against the pattern surface under jolting action. However, because of bridging and keying, nonuniform flow occurs, especially as the vertical depth of the casting increases and in deep pockets. Because the sand away from the pattern surface packs less than at the pattern surface, it is often necessary to finish off the top or back of the mold by ramming with a pneumatic rammer.

USED ON HEAVY WORK

Jolt machines, sometimes called bumpers, are useful in handling many sizes of flasks, especially when larger molds are rammed up on a molding floor. A pin-lift pattern-stripping arrangement (also called a push-off), is used when only one mold half is made. Loose patterns or separate cope and drags may be molded. Heavy flasks are drawn from the pattern by overhead crane. Large core boxes may also be used on jolt machines. It may be noted that the limiting capacity of a jolt machine is that total weight which it is able to lift and

Table 4 . . Squeeze-pressure Chart*

Squeeze piston diam, in.	Squeeze piston area, sq in.	Total effective pressure developed at line pressure of 80 psi with allowance for average load	Squeeze pressure/sq in. (80-lb line pressure at machine) 25	30	35	40	45	50	60	70
10	78.5	5,700	228	190	163					
12	113.1	8,300	332	276	237	208	185	166		
13	132.7	9,800	392	326	280	246	218	196	163	
14	153.9	11,200	448	374	320	280	249	224	187	160
15	176.7	12,300	492	410	352	308	273	246	205	176
16	201.1	14,000	560	466	400	350	311	280	233	200
18	254.5	18,000	720	600	514	450	400	360	300	257
19	283.5	19,800	792	660	566	495	440	396	330	283
20	314.2	22,000	880	734	628	550	489	440	367	314
21	346.4	23,800	952	794	680	595	528	476	397	340
24	452.4	31,400	1256	1045	896	785	697	628	527	448
28	615.8	43,500	1740	1450	1242	1174	966	870	725	621
30	706.9	49,100	1964	1635	1402	1228	1090	982	817	701
33	855.3	59,300	2372	1973	1690	1483	1316	1186	987	845
36	1017.9	70,200	2808	2340	2006	1757	1560	1404	1170	1003

*From E. A. Blake.

To use table, multiply length and width of mold to get area. Then find mold areas in above table nearest to your area. Squeeze piston diameters on pressures per square inch on mold can then be readily determined.

let fall, and this can be defined as follows:

$$W_j = \frac{\pi d_j^2}{4} \times P$$

where W_j = total weight which can be lifted by jolt cylinder, lb = flask weight + pattern weight + sand weight + jolt-table weight

d_j = diam jolt cylinder, in.

P = air-line pressure

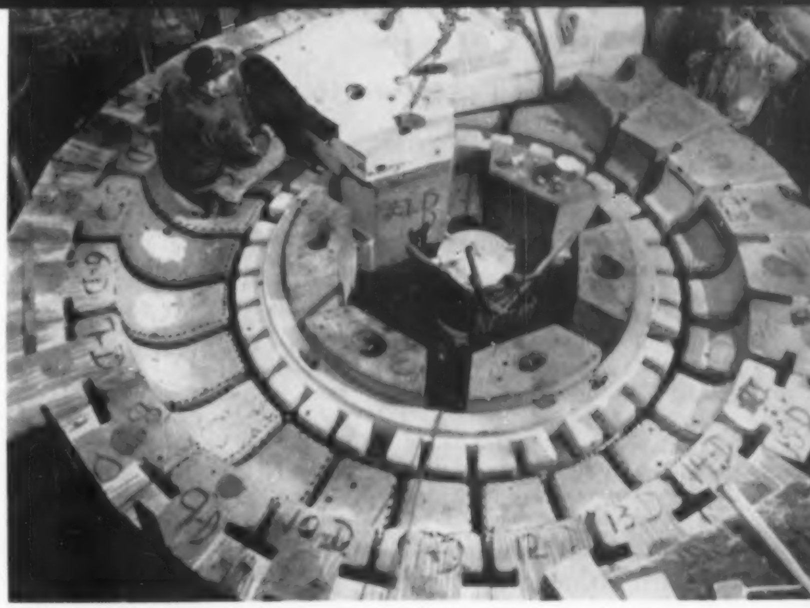
Molding sand weighs about 90 to 100 lb per cu ft. Jolt capacities of 500 lb to several tons are available in commercial machines.

Pattern Stripping. The elimination of the operation of stripping the pattern from the mold by hand speeds molding and removes one of the sources of damaged molds and dimensional variation of the mold cavity. Mechanical pattern stripping can be performed by pushing or lifting the flask away from the pattern table. The pattern or its mounting table is vibrated before and during the stripping operation. A slow withdrawal of the pattern during the moments when it leaves the sand is desirable. These steps are incorporated in pin lifts or lifting-bar strippers which push on the flask, separating the pattern from the mold. Generally, on molding machines, the pattern is lowered away from the mold while the pins or bars hold the flask up.

Jolt-squeeze Machines. Jolt-squeeze machines utilize a combination of jolting and squeezing to pack the molding sand. Post-type and cantilever squeeze heads are available, and the machines may be portable or stationary. These machines, without pattern-drawing features, are used mainly for match-plate molding. For this purpose a jolt capacity of 500 lb is adequate, since the molds are generally small enough so that one man can handle them.

MATCH PLATE MOLDING

With the match plate between cope and drag, the drag half is molded first using the jolt action. The bottom board, fitting inside the flask, can be jolted against the sand to seat it. Then the assembly is rolled over and the cope molded. On most match-plate work this is done by squeezing with a squeeze plate that fits inside the flask. Thus cope and drag are squeezed simultaneously. The pouring basin can be molded by a pattern attached to the squeeze board, while the sprue may be cut by hand or attached to the pattern. Match-plate molding using jolt-squeeze machines is perhaps the simplest method of speeding up the molding of small castings.



Setting first inside core of a pump case. The arrangement of cores is secured by ramming molding sand between them and the pit walls.

Jolt-squeeze Stripper. Pattern-stripping devices, pin lifts, or flask frames are added to jolt-squeeze machines when only one mold half is made on the machine. Machines of this type are used for separate cope and drag molding. One man and one machine may be used for making copes and one for drags to speed up molding. A third man can function as core setter and helper. Some typical machine-capacity characterisitics of certain jolt-squeeze pin-lift machines are given in Table 5. The limiting sizes of mold which can be produced depends on table size, maximum jolt load, squeeze capacity, height of pattern draw, stripping-pin center-

Table 5 . . Typical Specifications for Jolt-squeeze Stripper Machines, Post Type with Swing-arm Squeeze Head

General specifications	Portable or stationary	Portable or stationary	Stationary	Stationary
Table size, in	20 by 27	21 by 30	23 by 31	25 by 34
Recommended max jolt load, lb, at 80 lb air pressure	600	800	1000	1500
Squeeze cylinder diam, in	11	13	14	16
Squeeze capacity, lb, at 80 lb air pressure	7200	10,000	12,000	16,000
Pattern draw, in	4 or 6	6 or 8	6 or 8	6, 8, or 10½
Stripping-pin center line, front to back, in.	12 min, 22 max	25 max 12 min,	13½ min, 26 max	14½ min, 31 max
Stripping-pin center line, left to right	14½ min, 21½ max	14½ min, 23½ max	16 min, 25 max	19 min, 29 max
Distance, in., table to squeeze plate	12 min, 20 max	18 min, 24 max	18 min, 24 max	18 min, 24 max 20 min, 26 max
Distance, in., floor to table	27	28	28 or 30	28½ or 32
Distance, center of table to back support, in	10¾	13	14	17½
Shipping weight, lb, approx	1500	1900	2200	3650 or 3850

line distances, and distance from table center to squeeze plate and back support.

Table Size. Table size limits the effective area for attaching patterns or bolster plates. The underside of the work table is provided with recesses and places to bolt the pattern equipment solidly to the table.

Maximum Jolt Load. As defined earlier, the maximum jolt lifting force must be greater than the weight of all patterns, flask, sand, and table pushing down on the jolt piston. These capacities are given in Table 5 for the machines being considered.

MOLDING PRESSURES

Squeeze Capacity. The maximum molding force of some typical small-sized jolt-squeeze machines is given in Table 5. Many machines are equipped with air-pressure relief valves which permit any desired value of air pressure below that of line pressure to be applied. For example, if line pressure is 80 psi the relief valve may be set to bypass anything over 50 psi in the squeeze cylinder. Then, the actual molding force is some value less than the maximum and can be calculated with Eq. (1). Thus, by adjusting the air-pressure relief valve the molding force can be adapted to the flask size to result in a squeeze pressure [actual molding pressure, Eq. (2)] suitable to the casting requirements. Presently recommended molding pressures are as follows:

Aluminum, brass, light iron	20-25
Medium iron	25-35
Heavy iron	35-45
Light steel	35-50
Medium steel	40-55
Heavy steel	50-75

However, some foundries operate at much higher squeeze pressures. It must be recognized that molding pressure is not the only factor of importance in squeezing. The ability of the sand to flow under load and the amount of prior jolting greatly affect the hardness of the mold when jolting and squeezing are used together. Certain types of casting defects in some castings may be avoided by squeezing at some pressure other than that recommended above.

Height of Pattern Draw. This dimension limits the pattern depth which can be drawn free and clear of the mold. If additional lifting straight up can be done with hoists, much deeper patterns can be drawn.

Stripping-pin Center-line Distance. The stripping pins are adjustable through a swing of 360° and in several positions. The pin center-line distances determine the minimum and maximum size of flask for which the machine is intended. This is indicated in Table 5 for some typical machines. In place of stripping pins, bars, frames, or yokes may be used.

Car-type Jolt-squeeze Strippers. Large-sized jolt-squeeze stripping machines are often used in high-production work for medium-sized castings. The jolt-squeeze action is similar to that of the machines already considered. The squeeze plate consists of a car mounted on wheels and a track. In the squeeze position, the car is rolled over the mold before squeezing and functions as the squeeze plate. Stripping is accomplished by lowering the pattern away from the mold while the strip frame or stripping rails hold up the flask. The flask is removed from the machine when the squeeze-platen car is rolled out of the squeeze position. Lifting hooks on the car engage the flask, carry it out, and deposit it on a roll-out conveyor. The machine is used for making copes and drags although drags must be rolled over outside the machine. It is especially suited to production work when only one size of flask is used so that the roll-out conveyor and stripping frame are standardized.

Jolt-rockover Pattern Draw. The jolt-rockover pattern draw is a machine used for separate cope and drag work, molding the drag only. The drag is jolted and then finished off by pneumatic ramming and bedding in of a bottom board. Some models known as jolt-squeeze-rockover draw machines have a squeeze head. Then the drag may be finished by squeezing. The drag then is clamped and rocked over onto the leveling bars (equalizers) and the pattern is lifted away from the molds.

This drawing action simplifies drawing patterns that have deep pockets on them. A long sand projection will often drop out of a mold when the pattern is stripped by drawing it downward away from the mold cavity. In the rocked-over position, sand projections in the mold are not hanging in tension; so drops do not occur. Slow drawing of the mold as it first leaves the pattern assists in a clean draw. Many rockover machines are equipped with automatic slow drawing during the first inch of the draw, and a more rapid draw for the balance of the pattern-draw travel. Machines of this type can be used on heavy drags which can be rocked over to conveyors or can be transferred by crane to conveyors for closing and pouring.

Plain Rockover Draw. The rockover pattern-drawing mechanism is useful without the jolt action. A drag may be molded on the rockover table by some other means, such as with the sand slinger. Then pattern drawing may be accomplished by rocking over.

PATTERN SIZE FLEXIBILITY

Rockover machines have a considerable degree of pattern-size flexibility. Flasks are limited in width to a maximum of the size which will fit within the bottom-board clamp. However, the length of flask is not limited except to that which will jolt effectively. Table size, jolt, and squeeze capacities can be treated as was done in the case of the jolt-squeeze machines.

Jolt - squeeze - rollover Pattern Draw. Jolt-squeeze-rollover pattern-draw machines are used for the drag in cope and drag molding. The rollover mechanism permits pattern drawing by lowering the mold away from the pattern. The pattern plate is mounted on the rollover table. The jolt table, squeeze head, and pattern-draw mechanisms are below the rollover table. The jolt table is raised to engage the rollover table for jolting after the flask has been filled with sand.

After the rollover table is jolted, the flask is struck off by a strike-off bar pivoted on the main frame

which leaves a fixed height of sand above the flask bottom. Then a bottom board, which in the case of this machine is also the squeeze board, is held against the sand by quick-acting clamps which are part of the rollover table. The table and mold are then rotated 180° about their approximate center of gravity (axis of rotation).

RETURN-STROKE DRAW

The squeeze piston in the combination jolt-squeeze pattern-draw mechanism then squeezes the mold against the rollover table which is above the mold. The pattern is drawn on the return stroke of the piston by allowing the mold to travel down with the piston. The squeeze action in this case is limited to movement of the bottom board against the flask frame. The effect of squeezing under these conditions depends on the amount of extra sand in the flask, i.e., height of sand above the flask bottom after being struck off. The molding pressure, *M.P.* from Eq. (2), does not apply to this type of squeezing, the actual pressure being less than the maximum exerted by the squeeze head, with the balance being taken up by the flask frame. The greater the amount of extra sand in the flask before the squeezing, the closer the actual molding pressure approaches the maximum available from the squeeze head.

HIGH-PRODUCTION MOLDING

Jolt - squeeze - rollover pattern-draw machines are more limited in flexibility than the types considered thus far. Flask width is limited by the overhang of the flask to that which can be handled in squeezing and stripping. Flask length is limited to that which can be handled by the clamping mechanism on the rollover table. However, since these machines are used most often for high-production specialized molding jobs, such as automobile motor-block castings, they can be selected for the intended flask size.

A variety of special molding machines based on variations of the jolt-squeeze pattern-stripping principles are in use. For instance, a *vibrating-squeeze pattern-draw* machine has been devised. As the mold is squeezed, rapid jolts are applied to the pattern table on the horizontal direction. This assists in sand flow under the squeeze pressure and is supposed to produce a more uniform mold by squeezing.

Plain strippers are used in conjunction with other molding machines. The mold may be rammed up by any means on a pattern plate mounted on the stripping table. Then the pattern can be drawn by lift pins or stripping frames.

Cores may be molded in core boxes on jolt tables or jolt-rockover machines and drawn by the pattern-draw features of the rockover or rollover type.

Sand Slingers. Sand slingers are molding machines which pack the sand by the impact on the pattern of sand moving at high velocity. Sand is conveyed by belt into the slinger head, a housing 19 or 22 in. in diameter. The slinger head contains a rotor equipped with 4- or 5-in. blades that pick up the sand as it falls into the head and throw it against the mold. The rotor and blades, traveling at 1800 rpm, are capable of imparting a maximum velocity of about 10,000 fpm to the sand. A slow speed, 1200 rpm, is used to avoid pattern damage in placing the first sand on the pattern while the faster speed is used for the backup sand. The machine operator, by bouncing or rolling the first sand in the mold off the flask edge and sides, can minimize pattern wear caused by the blasting effect of the sand.

Slingers of several different models are used, including the following:

1. *Stationary slinger.* The operator rides a seat next to the slinger head and controls its movements by a "joy stick" which hydraulically operates the translational movements of the head for filling the flask. The slinger is fixed in its location and is used for ramming up molds that pass under its head on a conveyor or conveyors. Other stationary models may be operated from remote-control positions.

2. *Tractor sand slinger.* A tractor slinger can do its own sand handling by picking up sand from windrows, reconditioning it, and feeding it back to the slinger head which travels behind. The tractor slinger can ram up molds which are within reach of the slinger head.

3. *Motive slingers.* These are fed with conditioned molding sand in tanks. The unit travels on rails and can ram up molds anywhere within reach of the arc of slinger-head ro-

Automatic, roll-over-type, shell molding machine with double dump box for simultaneous cope and drag. At right is a glueing machine.

tation. They generally are used in producing medium and larger sizes of castings, for floor and pit work located along the track traveled by the unit. Especially in large work, slingers have the advantage of filling the flask rapidly and ramming the sand at the same time.

Slingers have great versatility in size of mold, width, length, and depth which can be rammed. Loose patterns may be used, or in production work separate cope and drag plates are suitable when the unit is mechanized. Their principal restriction is the distance from the floor to the slinger head. Patterns, mold boards, work tables, flasks, stripping machines, etc., must of course clear the slinger head. Obviously, if the slinger is too far off the floor it may be too far from the mold, and the sand thus loses its ramming velocity and would not be rammed adequately. In view of the squeeze pressures presently employed, it appears true that slingers are able to ram molding sand harder and to greater density than the other molding methods. However, this might not be true if higher squeeze pressures were used.

MOLDING ACCESSORIES

In addition to molding machines, much allied equipment and materials may be used for green-sand molding. Some of these items will be briefly considered.

Flasks. The flask consists of the frames necessary for molding and handling the cope and drag. Molding flasks may be classified as follows:

1. Removable flasks
   a. Snap
   b. Pop-off
   c. Slip
2. Tight or permanent flasks

Removable flasks are used for match-plate molding and cope and drag molding of small to moderate size. They are convenient since only one flask is required per machine setup. After the mold is made, the flask is removed and replaced with a jacket so that the mold may be weighted and poured. The *slip flask* has sides tapered 4° for removal of the flask from the mold. A cam-actuated retractable shelf, called a sand strip, is attached to the cope so that the cope may be lifted off for pattern removal. In *pop-off-type flasks,* the sand is held in place by corrugations on the tapered sides. Pop-off flasks have expansible sides and can therefore be removed after the mold is completed. *Snap flasks* are hinged on one end so that they can be opened. They have a fixed sand strip at the parting surface for holding up the cope.

Removable flasks are subject to warpage if dropped or mishandled and do not provide the most rigid support of the mold. Flask sizes are usually described by their width and length at the parting surface; thus a 16-32 flask is 16. in wide and 32 in. long at the parting line. The depth of the cope and drag is also an important dimension, since it determines the pattern height which can be molded. The three dimensions are usually marked on the side of the flask. An inch and a half to two inches of sand is desirable as a minimum at the sides and bottom, more sand being safer.

The cope height determines the height of the sprue and thus the metallostatic pressure applied to the molten metal. High copes, i.e., high pressure, favor elimination of gases and promote feeding but also may cause mold-cavity enlargement. Removable flasks allow the mold to be vented easily, but tight flasks may prevent gas relief unless escape holes are provided.

Tight or *rigid* or *permanent* flasks remain on the mold until after the casting is poured and shaken out. Hence a number of tight flasks are required for any one molding setup, one for each mold being processed. However, jackets are not required since the flask is used for both molding and pouring. Tight flasks are generally made of steel and have the advantage that they can be barred (reinforced) to make the mold more rigid and less liable to twist. Tight flasks are more resistant to warpage and assure a positive alignment of cope and drag through pins and bushings. The cope may be clamped to the drag instead of being weighted. However, these flasks are heavy, usually require mechanical handling, and involve greater initial cost.

Upsets may be used on any flask to increase the depth of cope or drag. They are frames, usually metal, bolted to the top of the cope or bottom of the drag.

Jackets are used in connection with removable flasks. The unsupported mold is enclosed in a metal, wood, or asbestos board frame, i.e., jacket. The jacket side walls have taper corresponding to that of the removable flasks, about 4° on the vertical. Jackets must fit well and must not be warped or twisted, in order to prevent runouts or mold cracking when the metal is poured. Generally, a jacket is required to have its upper edge below the cope surface so that mold weights may rest on the cope surface of the mold. Jackets may be shifted from mold to mold as pouring progresses, but only after the casting has solidified.

Bottom Boards Squeeze Boards. For jolt-squeeze molding, a bottom board is required to fit inside the flask frame with about ¼ in. clearance all around its periphery. Different sizes of flasks therefore require different sizes of bottom boards. If the flask is reinforced no bottom board is required. In some squeeze work, a bottom board is used which just engages the bottom edge of the flask, as, for example, the rollover molding operation discussed earlier. Bottom boards are made of wood, asbestos board, or aluminum.

Squeeze boards also are usually required to fit inside the flask frame. However, since the squeeze board is used for the cope, only one is needed per molding setup. It may be attached to the squeeze head of the molding machine where the pattern and flask are in a fixed position as in cope and drag molding or jolt-squeeze machines. In special cases, a contoured squeeze board may be used to obtain a more uniform squeezing action around the pattern. The pattern for the sprue cup or pouring basin can be mounted on the squeeze board.

Weights. The cope mold half must be held down to keep it from floating when the metal is poured. Metallostatic pressure exerts a

buoyant effect on the cope which can be calculated from the following relationship:

$$F_c = P_c A_c$$

where F_c = force pushing up on the cope

P_c = metallostatic pressure at cope parting surface

A_c = projected mold-cavity area at cope parting surface

P_c is calculated as follows:

$$P_c = wh$$

where w = weight per cu in. of metal

h = effective height of metal head above cope

If the casting is all in the drag, the sprue height is the effective height of the metal head above the cope. With some casting in the cope, the effective head is less than the sprue above the parting line. However, the latter may be used as a safe figure. Simplifying, it can be seen that, for ferrous castings, assuming 0.26 lb per cu in. for w, the force pushing up on the cope is 0.26 lb per sq in. of projected cope area per inch of sprue height, or

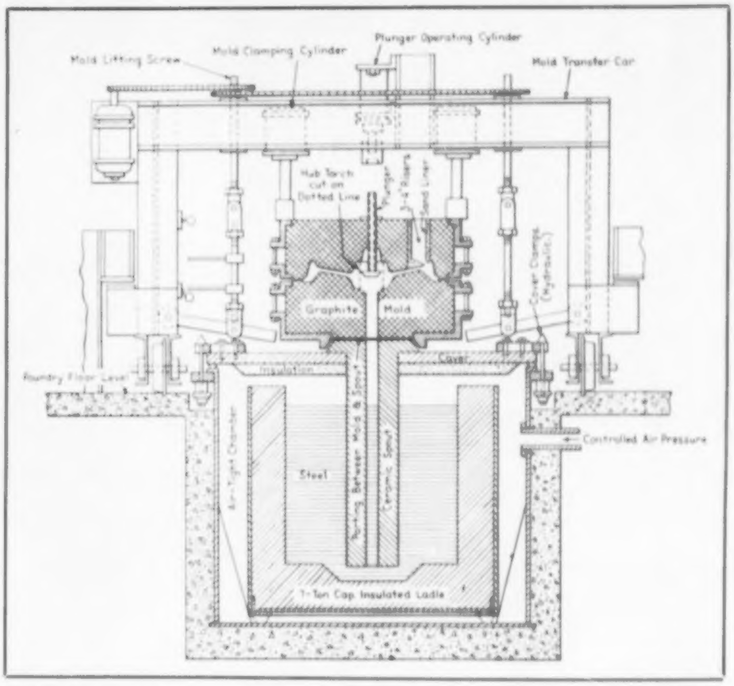
$$F_c = 0.26 A_c h_s$$

where h_s is sprue height in the cope. If the weight of the cope itself is subtracted from F_c, the additional weight required to resist static pressure is obtained.

Since metal being poured has momentum, a dynamic pressure may be exerted in addition to this static pressure on the cope. A safety factor of 1.5 to 2.0 can then be used on the calculated value to overcome the dynamic-pressure effect. A mold weight based on the total flask area at the parting line can be a safe weight.

Weights are then required to hold down the cope and must be available in different sizes to suit the flasks. Of course, weights may be shifted from mold to mold as pouring progresses. Tight flasks may be clamped together rather than weighted.

Venting Frames. These are shallow metal frames or gridwork of the size of the flask and are used for venting the mold. Long prongs are attached to the gridwork and project into the molding sand. After the flask is rammed by squeezing or slinging, holes are left in the mold upon removal of the vent frame. These vent holes assist in passing off mold gases when pouring begins. Vent frames are used only on high-production molding where tailor-made molding accessories are possible.



Graphite molds for casting steel railroad car wheels are filled by forcing metal out of the ladle with compressed air up to 22 psi.

FOUNDRY MECHANIZATION

Two developments were required so that foundries could be mechanized. First, machines had to be designed and built which could perform foundry operations such as molding, coremaking, and sand mixing. Second, these machines had to be integrated with materials-handling equipment so that continuous processing could be accomplished in the foundry. Since it is estimated that from 50 to 200 tons of material are handled or rehandled to produce a ton of castings, the importance of good materials handling cannot be overemphasized. This basic idea is recognized in modernization or mechanization as it is applied in foundries.

Since there are certain basic steps in the metal-casting process, these may be used as units of mechanization. Processing steps which lend themselves to mechanization are the following:

1. Sand preparation for molding and coremaking
2. Coremaking
3. Molding, pouring, and shakeout
4. Melting
5. Cleaning

Since materials and equipment converge at the molding operation and diverge after pouring, this is an important point in the complete cycle. For molding to progress, molding sand must be delivered to the molding machines as rapidly as required.

Sand Preparation and Handling. About 4 or 5 tons of sand is prepared and handled per ton of castings produced in a typical ferrous foundry. Because of this and the fact that the sand so greatly influences the quality of the castings, much attention has been devoted to this part of mechanization.

While a flowsheet of sand circulation in a mechanized foundry can be built up into a very extensive mechanized sand-handling system, many of its elements exist to some degree in even the simplest system. Mixing of the sand with water and clay is required in all systems. Aeration, separating the sand grains, may be accomplished by having the molder manually riddle or screen sand onto the pattern.

NEW SUGAR FORMULA MAKES SWEET CORE BINDER

CHARLES J. GOGEK
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Corn sugar, with ammonium sulphate as a catalyst, gives cereal-bonded cores high baked strength with less core gas

■ In conventional foundry practice, sand is charged into a muller and followed by successive additions of cereal binder, water, and core oil with an appropriate mulling period after each addition. The use of sugars in foundry sand mixtures is mentioned only occasionally in the technical literature. Research in these laboratories has resulted in a sugar-based binder, the utility of which has been amply demonstrated in actual foundry operations. Results of laboratory tests and a brief discussion of foundry trials are presented in this paper.

The new binder is a white, water-soluble powder containing over 90 per cent of corn sugar. Corn sugar is commonly called dextrose, and in this paper the binder will be referred to as "dextrose binder". The remainder of the product consists of a suitable catalyst (e.g., ammonium sulphate) which converts the dextrose into a resin-like substance during baking. A basic core mixture, therefore, contains sand, water, cereal binder (to provide green strength), and dextrose binder (to provide baked strength). Suitably formulated and prepared, such a mixture possesses all the properties required to form green cores by the usual methods. These cores, when properly baked, develop the bonding properties of the dextrose binder, and the cooled baked cores meet service requirements customarily demanded by foundrymen.

During baking, the green cores acquire a dark brown color, due to transformation of the dextrose into resinous substances under the influence of heat and in the presence of the catalyst. Although properties of the new binder resemble those of resins in some respects, it would be misleading to classify dextrose binder in the group of materials presently marketed as resins for foundry use.

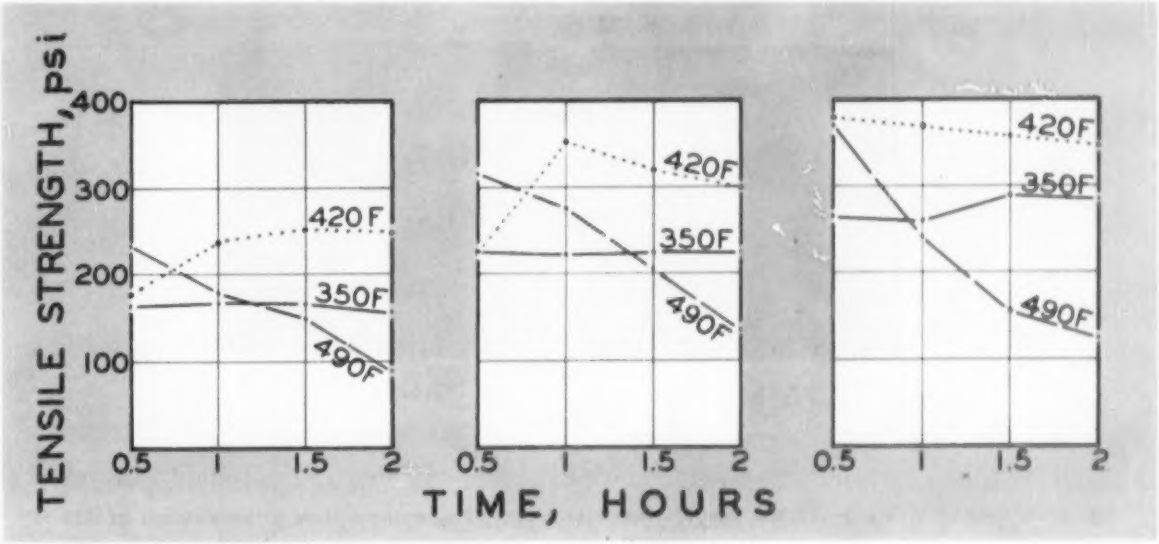

Fig. 1 . . Tensile strength of specimen cores baked at different temperatures for different periods.

Mixture:

Standard Sand		3000 gr
Cereal Binder	1%	30 gr
Dextrose Binder	1%	30 gr
Water	3%	90 ml

Mixture:

Standard Sand		3000 gr
Cereal Binder	1%	30 gr
Dextrose Binder	2%	60 gr
Water	3%	90 ml

Mixture:

Standard Sand		3000 gr
Cereal Binder	1%	30 gr
Dextrose Binder	3%	90 gr
Water	3%	90 ml

Green Sand Mixing. By the presently described process, dextrose binder is added with the cereal binder, the mixture is mulled, water is added, and the mixture is mulled again. Complete dispersion is achieved without difficulty in common sand mixers on a laboratory and production scale.

Dextrose binder makes a small but positive contribution to green strength as shown in Table 1 for AFS silica sand; similar results were obtained using a lake sand. Standard AFS procedures were used in all tests.

Increasing amounts of dextrose binder in a sand do not increase green strength as cereal binder does. The "plastic feel" imparted to a sand mixture by cereal binder is not developed with dextrose binder. Core specimens in Table 1 had permeabilities of 180-200 (green) and 235-255 (baked).

Where equipment for pumping and metering liquid binders is available, the use of a suitably compounded corn sugar syrup binder is equally effective, as illustrated in Table 1.

Properties of Baked Cores. An electrically heated oven fitted with a circulating fan was used for baking cores. As shown in Table 1 and Fig. 1, higher percentages of dextrose binder increased the tensile strength of baked specimen cores. Baking time required to reach peak strength diminished as dextrose binder content increased. Thus, at an oven temperature of

Skin drying floor molds with torches produces a partial effect of dry sand molds; they must be poured before moisture works back.

Magnetic separation of tramp iron can be ignored if special facing is used next to the pattern as can lump breaking and screening after shakeout. However, the best and most thorough sand preparation is necessary in high-production foundries.

A simple conditioning system involving mechanical preparation makes use of a cement floor and the sand cutter. The castings are shaken out on the floor and picked up in dump buckets. Water and clay bond is sprinkled on the hot sand in amounts which experience has shown to give satisfactory results. The sand cutter picks up the sand and with a violent mixing action whirls it in a heap against a wall adjacent to molding machines. If special facing sand is required, trucks may deliver this sand, separately prepared in mullers, to the molding station. The molds are made and set out on the floor for pouring. For separation of tramp iron, the sand can periodically be hauled by scoop truck to a magnetic separator. With conditioning of this type, the more easily prepared natural molding sands are desirable. Aeration of the sand can be accomplished by a combination of screening and fluffing action.

More positive sand-mixing action can be obtained through the use of mullers or intensive mixers. The muller can be incorporated into a system of conveyors, hoppers, and storage bins. A centrifugal-type of mulling machine can be loaded by scoop truck and unloaded into buckets for rapid transfer to molding stations.

Whatever the sand-conditioning system and equipment, it has a pronounced effect on the quality of the sand for molding.

Molding-line Mechanization. By combining molding machines with conveyors, a pouring station, cooling, and shakeout, the operations from molding through to shakeout may be mechanized. Sand is delivered to the molding stations from the conditioning system, usually into hoppers above the machines. Molding can then be performed using any one or a combination of the types of machines discussed earlier. Probably the simplest molding-line mechanization consists of a row of molding machines, usually jolt-squeeze machines doing matchplate molding, light cope and drag molding, or stack molding located at the end of a roller or rail-type conveyor. Sand is delivered from a preparation system to overhead hoppers at the molding stations. The molding end of the conveyor provides a space for core setting and mold closing and a buffer zone for the accumulation of unpoured molds. A section of the conveyor is served by monorail or other means of handling ladles for pouring. The balance of the conveyor is for cooling and a buffer zone for mold storage for shakeout. Shakeout may be accomplished by transferring the molds to a separate shakeout or dumping them off the mold conveyor into an oscillating conveyor which delivers them to a shakeout unit. The mold conveyors may be either gravity-acting or powered.

Stack Molding. Stack molding is a type of mechanized molding designed to increase greatly the number of castings made per mold. The mold consists of a number of permanent flask sections stacked up. Each flask section has a drag cavity molded in its upper surface and a cope section molded in its lower surface. Both cavities are molded simultaneously by having the cope pattern mounted on the jolt table and the drag pattern mounted on the squeeze platen of a jolt-squeeze pin-lift machine. The amount of sand in the flask is controlled by means of a strike-off frame so that after squeezing the mold hardness is correct and there is sufficient sand for a good seal at the parting. The mold is stacked up with a number of flask sections as they are molded.

Stack molding is extensively used for light castings such as piston rings, chain links, and levers where the weight of the stacked castings amounts to 50 to several hundred pounds. The flask sections require that the castings be relatively shallow. This type of molding requires that the balance of the operations be mechanized for the best production results. Sand conditioning, pouring, shakeout, and cleaning must be suited to handle the volume of castings stack molded.

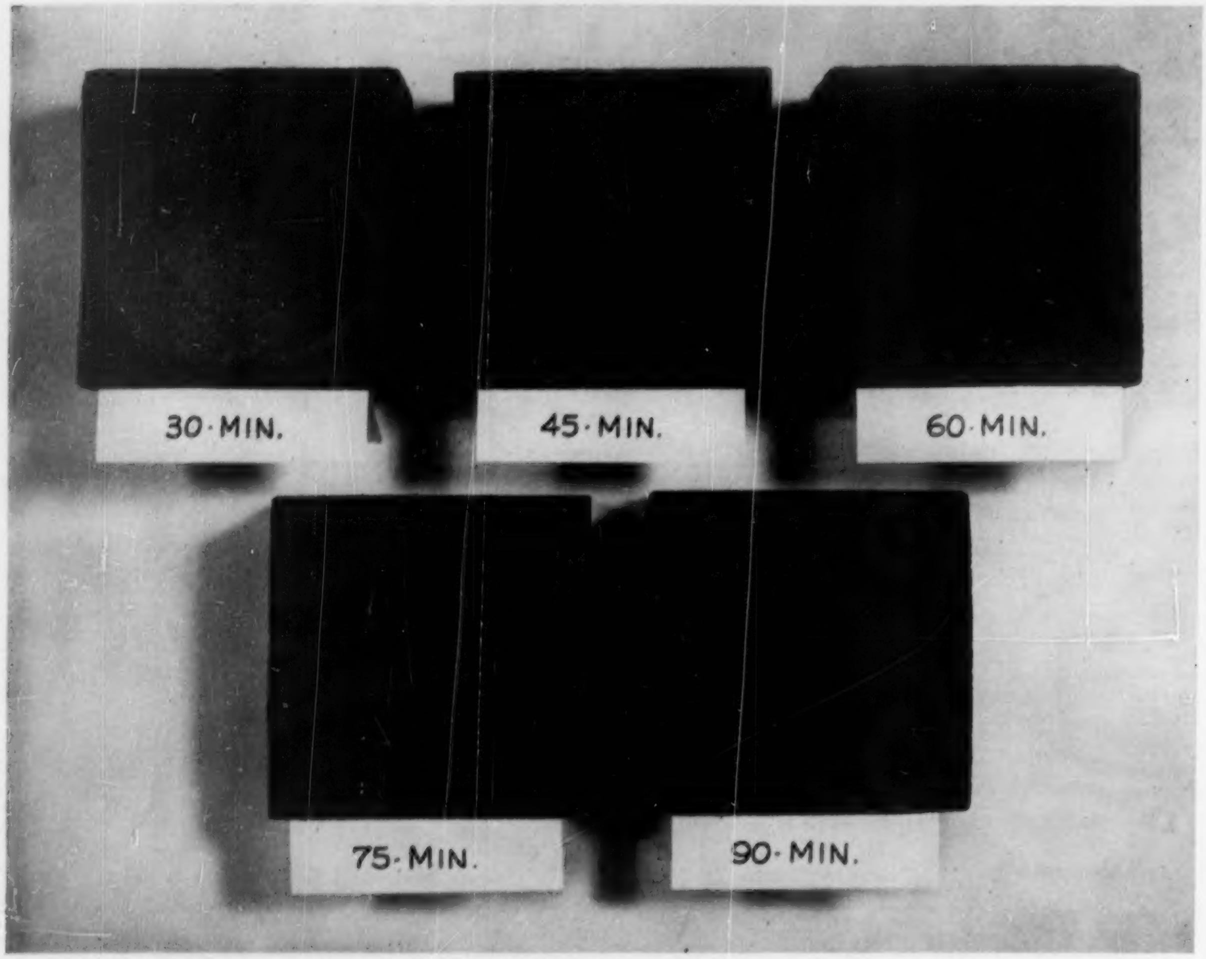

Fig. 2 . . Bakability, scoop-out test on 1% dextrose binder, 3% water mixture at temperature of 425 F.

420 F, core swith 1, 2, and 3 per cent dextrose binder attained peak tensile strength after baking periods, respectively, of slightly more than one hour, one hour, and one-half hour.

Figure 1 also shows that oven temperatures above 350 F should be used to develop peak strength from dextrose binder; peak strength is developed very rapidly at 490 F but is also lost rapidly with continued baking. At 420 F, optimum tensile strength diminished slowly as the cores were "over-baked". Oven temperatures of 400-450 F are recommended for baking cores containing dextrose binder. Most industrial core ovens are operated in this range.

Since temperatures of 400-450 F are necessary for development of maximum strength from dextrose binder, the bonding is not due merely to loss of free moisture, which occurs at much lower temperatures. The actual bonding mechanism is unknown. Tentatively, bonding action is ascribed to progressive polymerization of the dextrose.

Table 1 . . Properties of Dextrose Bonded Sands*

Binder	%	Green Compressive Strength psi	Baked Tensile Strength psi
Cereal	1	0.56	85
Dextrose	1	0.60	180
Cereal Dextrose	1 1	0.60	235
Cereal Dextrose	1 2	0.58	300
Cereal Dextrose	1 3	0.61	355
Cereal Corn Syrup (solids)	1 1	0.58	250

*Mixture: 3000 gr AFS standard silica sand, binder based on weight of sand, and 90 cc (3%) water; mulled dry 1 min, wet 4 min in a heavy-wheel-type muller. Cores were baked at 415 F for 1 hr.

Scratch hardness of baked cores containing dextrose binder parallels tensile strength. Baked specimens which break in the range of 150-200 psi show scratch hardnesses of 80 to 90, and those which break above 200 psi have hardnesses of 90 to 100. Specimen cores listed in Table 1 appeared equally hard in the center, indicating uniform bonding throughout the core.

Fully baked cores containing dextrose binder are darker brown than corresponding cores prepared with core oil. Color of the core is a good index of completeness of baking. Underbaked cores frequently consist of a dark brown crust enclosing a light central portion, which may be dry and hard, or wet and soft, depending on the degree of baking.

A better idea of the bakability of core sand mixtures may be obtained from Fig. 2. Each core in this figure represents one-half of a 3-in. cube prepared from AFS standard silica sand containing 1 per cent dextrose binder and 3 per cent water, mulled 2 min dry and 5 min wet. The interior portion scooped out of the core which was baked 30 min represents unbaked sand. As shown, complete baking was attained in 45 minutes at 425 F.

Table 2 . . Moisture Effect on Tensile Strength*

Water	Tensile Strength (psi) of cores baked for		
%	0.5 hr	1 hr	1.5 hr
2	110	170	130
3	175	235	250
4	175	270	280
5	190	295	285
5	190	295	285

*Mixture: 3000 gr AFS standard silica sand, 30 gr (1%) cereal binder, 30 gr (1%) dextrose binder, and water based on weight of sand; mulled dry 1 min, wet 4 min in a heavy-wheel-type muller. Cores were baked at 420 F.

Moisture content of the green core mix has a substantial influence on tensile strength of the baked cores. Data in Table 2 show that at least 3 per cent moisture is necessary to develop maximum baked strength of the binder.

As moisture content is increased above 3 per cent, the mixture may tend to stick to the core box, and become difficult to blow. In some cases it may be difficult to strike off excess sand and leave a smooth surface. R. H. Greenlee reported similar results for core sands containing resins at comparable moisture levels in "Modern Core Sand Practice", Transactions, American Foundrymen's Society, v. 59, p. 412, (1951). Release agents were suggested to eliminate the stickiness problem, and aluminum or brass bars to minimize the strike-off problem; the former technique is effective in dextrose-bonded sands.

Another interesting conclusion from the results in Table 2 is that baking time to attain peak strength is not changed by moisture increases.

Table 3 . . Effect of Cereal on Tensile Strength*

Cereal Binder %	Green Strength psi	Tensile Strength (psi) of cores baked for 0.5 hr	1 hr
0.5	0.44	235	255
1.0	0.58	175	235
1.5	0.82	142	192

*Mixture: 3000 gr AFS standard silica sand, cereal binder based on weight of sand, 30 gr (1%) dextrose binder, and 90 cc (3%) water; mulled dry 1 min, wet 4 min in a heavy-wheel-type muller. Cores were baked at 420 F.

Table 4 . . Effect of Clays on Core Physicals*

Type of Clay	Green Strength psi	Tensile (psi) Cores baked for 0.5 hr	1 hr
Western bentonite	1.5	86	98
Southern bentonite	1.1	92	112
Ohio fire-clay	0.7	145	165
Illinois fire-clay	0.8	169	147

*Mixture: 3000 gr AFS standard silica sand, 30 gr (1%) cereal, 30 gr (1%) dextrose, 30 gr (1%) clay, and 90 cc (3%) water; mulled dry 1 min, wet 4 min in a heavy-wheel-type muller. Cores were baked at 415 F.

Amount of cereal binder and presence and type of clays also influence strength of baked cores containing dextrose binder. Data in Table 3 show that increasing amounts of cereal binder decreased tensile strength imparted by the dextrose binder. A similar effect is produced by clays (Table 4). Western and southern bentonites were more damaging than two common fire-clays. The loss in tensile strenth due to presence of clays or high amounts of cereal binder can be minimized by using more moisture in the sand.

Gas Evolution. All baked cores liberate gas under the heat of molten metal. Rate of evolution of gas is shown in Table 5 for several core sand specimens heated in a nitrogen atmosphere at 1850 F. Cores bonded with dextrose binder liberated less gas than those prepared with dextrose alone; this is one of the important effects of the catalyst. The volume of gas liberated from core sand prepared with both cereal binder and dextrose binder was less than the sum produced by each binder alone. Evidently the catalyst, likewise, reacted with cereal binder to reduce gas evolution.

The volume of gas evolved from cores containing dextrose binder decreased as baking time at 410 F increased. Test results (Table 6) obviously pertain to those cores which are largely surrounded by metal and where gas evolution must be minimized.

Table 5 . . Gas Evolution Related to Combustion*

Binder	%	cc Gas per gram Baked Core at 1950 F for Intervals in min of: 0.5	1	2	5	10	20
Cereal	1	10.4	10.7	11.0	11.2	11.7	12.4
Dextrose without catalyst	1	5.6	5.9	6.1	6.1	6.3	6.5
Dextrose	1	4.0	4.1	4.1	4.0	4.0	4.3
Cereal / Dextrose	1 / 1	11.1	12.0	12.6	13.3	14.2	15.2

*Mixture: 3000 gr AFS standard silica sand, 90 cc (3%) water, and binders as specified; mulled 1 min dry, 4 min wet in a heavy-wheel-type muller. Cores were baked at 410 F for 1 hr. Gas evolution at 1950 F in a nitrogen atmosphere.

Table 6 . . Gas Evolution Related to Baking Time*

Baking Time hr	Volume of Gas Liberated cc/gr Baked Core Sand
0.5	16.1
1.0	14.2
1.5	11.6
2.0	9.3

*Mixture: 3000 gr AFS standard silica, 30 gr (1%) cereal binder, 30 gr (1%) dextrose binder, and 90 cc (3%) water; mulled 1 min dry, 4 min wet in a heavy-wheel-type muller. Cores were baked at 410 F. Gas was collected for 10 min from combustion furnace at 1800-1850 F.

Table 7 . . Core Collapse and Expansion*

Binder	%	at 2000 F Collapse Time sec	at 2000 F Max Expans in./in.	at 2500 F Collapse Time sec	at 2500 F Max Expans in./in.
Cereal / Dextrose / Water	1 / 1 / 3	173	0.021	158	0.018
Cereal / Dextrose / Water	1 / 1 / 3	231	0.023	347	0.018

*Mixture: 3000 gr AFS standard silica sand, 90 cc (3%) water, and binders; mulled 1 min dry, 4 min wet in a heavy-wheel-type muller. Cores were baked at 425 F for 1 hr.

Table 8 . . Effect of Iron Oxide on Collapse*

Iron Oxide %	Collapsing time in sec at 2000 F	2500 F
0.15	217	166
0.50	264	600
1.0	600	600

*Mixture: 3000 gr AFS standard silica sand, 30 gr (1%) cereal, 30 gr (1%) dextrose, iron oxide as specified, and 90 cc (3%) water; mulled 1 min dry, 4 min wet in a heavy-wheel-type muller. Cores were baked at 524 F for 1 hr.

Collapsibility of Cores. A commercial laboratory determined collapsibility and thermal expansion at 2000 F and at 2500 F on baked cores containing dextrose binder. Standard baked specimens (1-1/8 inches diameter) were heated in air in a dilatometer (*Foundry Sand Handbook*, Sixth Edition, 1952, p. 154). During expansion, the core sustained a load of approximately 4 ounces. Results in Table 7 show that, as the amount of dextrose binder in a core was reduced, maximum expansion was unaltered but collapsing time decreased.

Effects of Iron Oxide

Experiments were also run on core sand mixtures containing various amounts of iron oxide (Table 8). As was expected, iron oxide increased collapsing time in all cases. Maximum expansion of these specimens was 0.021-0.023 in./in.

Dextrose-bonded core specimens were shock-heated for one minute at 2000 F and at 2500 F. At the end of this period, surface sand spalled slowly, without developing visible surface cracks. Cracking of a baked core under these conditions is probably related to veining in the casting, and it seems likely that dextrose binder will minimize this casting defect.

No attempt has been made to relate these results to core knockout under foundry conditions. The AFS committee on Physical Properties of Iron Foundry Sands at Elevated Temperatures reported that collapsibility determined in an air atmosphere is not related to ease of core shake-out: "Evaluation of Core Knockout", TRANSACTIONS, American Foundrymen's Society, v. 55, p. 313 (1947).

Foundry Trials. All of the common metals (viz., gray iron, steel, malleable iron, aluminum, brass, bronze, and magnesium) have been poured over cores prepared with dextrose binder and results were entirely satisfactory. Strainer cores, runner cups, and pouring basins containing dextrose binder have been satisfactory. A variety of other cores ranging in weight from a few ounces to several hundred pounds has given acceptable castings.

Acknowledgment

Assistance in laboratory and field work was rendered by Mr. P. C. Moreau, Mr. C. F. Lurich and Mr. W. H. Foley, all of Corn Products Refining Company.

ASTM Elects Officers, Makes Merit Awards

Claire H. Fellows, Detroit Edison Co., Detroit, was elected president of the American Society for Testing Materials for a one-year term at the 58th annual meeting, Atlantic City, June 26 to July 1. Among other ASTM activities, President Fellows is a member of technical committee A-5 on Corrosion of Iron and Steel. Elected vice-president for a two-year term was Richard A. Kropf, Belding Heminway Co., Inc., New York.

The following are new directors with three-year terms: F. L. LaQue, International Nickel Co., Inc., New York, member of B-3 on Corrosion of Non-Ferrous Metals and Alloys and A-10 on Iron-Chromium, and Iron-Chromium-Nickel, and Related Alloys; A. Allan Bates, Portland Cement Association, Chicago; Richard C. Alden, Phillips Petroleum Co., Bartlesville, Okla.; John C. Moore, National Paint, Varnish, and Lacquer Assn., Washington, D. C.; and E. F. Lundeen, Inland Steel Co., Chicago.

Awards of Merit were given to eleven leaders in the field of engineering materials for outstanding service to ASTM, particularly in its technical committee work. Honored were: Robert C. Adams, Jr., U. S. Naval Engineering Experiment Station, Annapolis, Md.; Boris J. Barmack, Commonwealth Edison Co., Chicago; Edward J. Kilcawley, Rensselaer Polytechnic Institute; Christopher E. Loos, U. S. Steel Corp., Pittsburgh, Pa.; Robert J. McKay, International Nickel Co., Inc., New York; William T. Pearce, consultant, Bala Cynwyd, Pa.; Nathan C. Rockwood, *Rock Products* magazine, Chicago; Robert B. Sosman, Rutgers University, New Brunswick, N. J.; George N. Thompson, National Bureau of Standards; William S. Young, Atlantic Refining Co.; William A. Zinzow, Bakelite Co., Bound Brook, N. J.

Honorary membership was extended to four persons of widely recognized eminence in their field of work covered by the Society or who have rendered especially meritorious service to ASTM. The four are: Thomas A. Boyd, Arthur W. Carpenter, William M. Barr, and Richard L. Templin.

THE CASE OF THE
ABSORBED OXYGEN

■ Gas content of ferrous metals has been studied for about 50 years, but most of the work has been done on steel, very little on cast iron. Consequently, information concerning the gas content, and particularly the oxygen content, of cast iron has been rather puzzling at times. One factor that has contributed to the confusion over oxygen in cast iron is the time elapsed between casting and analyzing the iron. The purpose of this paper is to point out the significance of this factor.

Scientific studies by thermochemists and physicists tell us that gray cast iron of normal silicon content should contain only about 0.001 to 0.004 per cent oxygen by weight. Many analyses of cast iron reported in the literature, however, show that actual specimens of cast iron contained much more than the theorectical amount of oxygen. Who is correct, the theoretical physicist or the foundry analyst?

As an example of high-oxygen irons, in 1934 Reeve reported that a piece of cast iron analyzed by him contained 0.047 per cent oxygen. This value has been frequently quoted and requoted in subsequent literature as an example of high oxygen in cast iron. From a coworker of Reeve, it has been learned that this specimen was from a piece of cast iron pipe which had been buried in the ground for years and which was known from metallographic examination to contain free iron oxide as rust that had penetrated into the pipe.

Hurst and Riley, who have done much research on the gas content of cast iron, reported on a specimen containing 0.019 per cent oxygen. This piece of iron was about 100 years old. After simple remelting it contained only 0.0020 per cent oxygen. The same investigators have reported that a piece of pig iron analyzed in 1945 contained 0.012 per cent oxygen. At the time of analysis, the iron was 25 years old. In another case, a specimen pin that contained a few small gas holes had an oxygen content of 0.017 per cent. The surface of the gas holes were tarnished by oxides. Adjacent sound specimens from the same pin contained only 0.0022 per cent oxygen.

Experiments at Battelle involving the oxygen content of gray iron during the last several years have yielded much support for the thermochemical data. Attempts have been made to produce high-oxygen, "oxidized," or "dull" gray irons in cupolas by the use of lean coke ratios, thin rusty scrap, and low bed heights, but it has been only on rare occasions that oxygen contents of more than 0.004 per cent were obtained.

This suggested looking elsewhere for an explanation of high-oxygen values in the literature. *In fact, study of the literature has not revealed a single high-oxygen value known to have been determined from a sound specimen analyzed shortly after casting.*

To determine whether the oxygen content of cast iron increases during storage, four different irons were analyzed for oxygen at intervals up to one year from the time each iron was cast. The irons used for this study were melted in an induction furnace and cast into ¼-in. plates in green sand molds.

Fig. 1 . . Vacuum-fusion apparatus used for the oxygen analyses of four different cast irons stored for intervals up to one year.

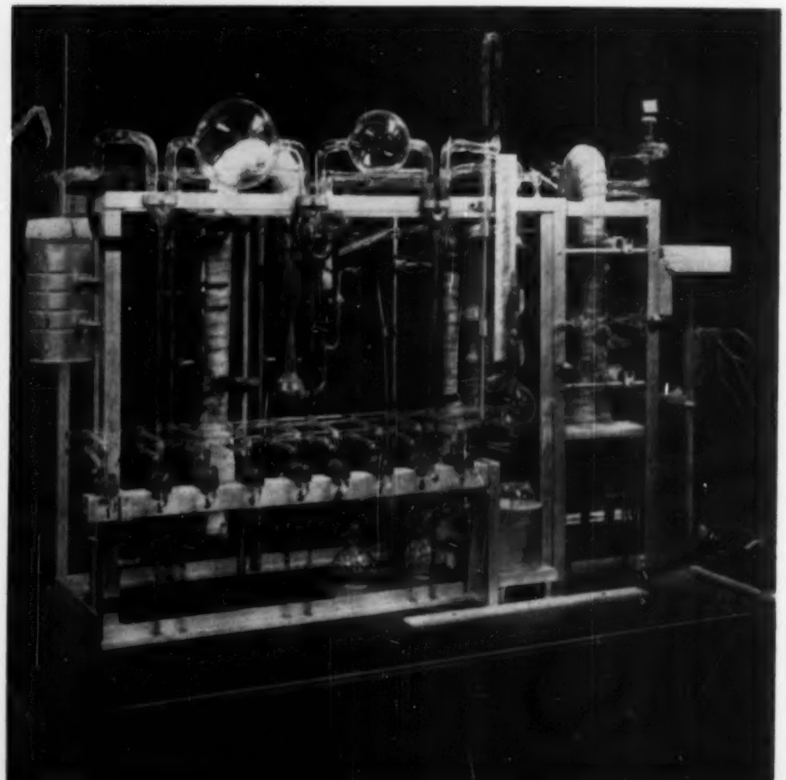

Fig. 7 . . Visual inspection of 100% overload tested chain revealed rare case of surviving cracked link; tag is final weld operation.

Fig. 8 . . Elongation or stretching of link in test reduces clearance and causes the chain to loose its flexibility and usefulness.

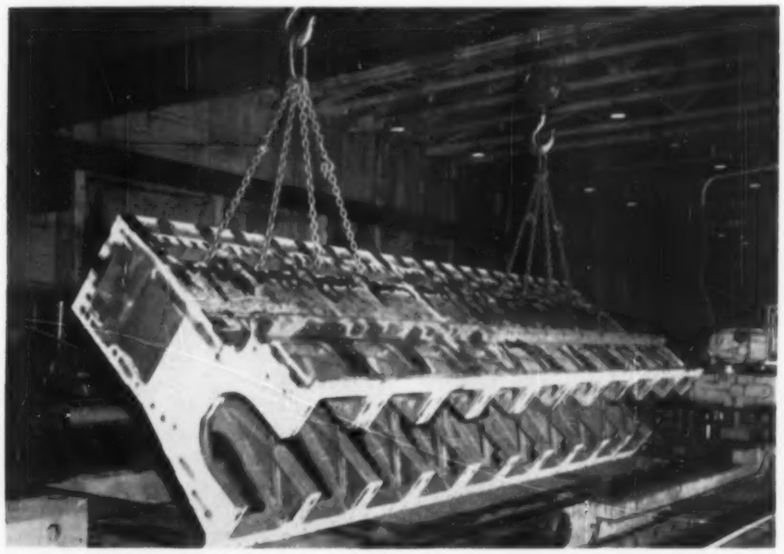

Fig. 9 . . Each 4-chain assembly has two grab hooks for balance, control, and easy adjustment in turning the diesel engine block.

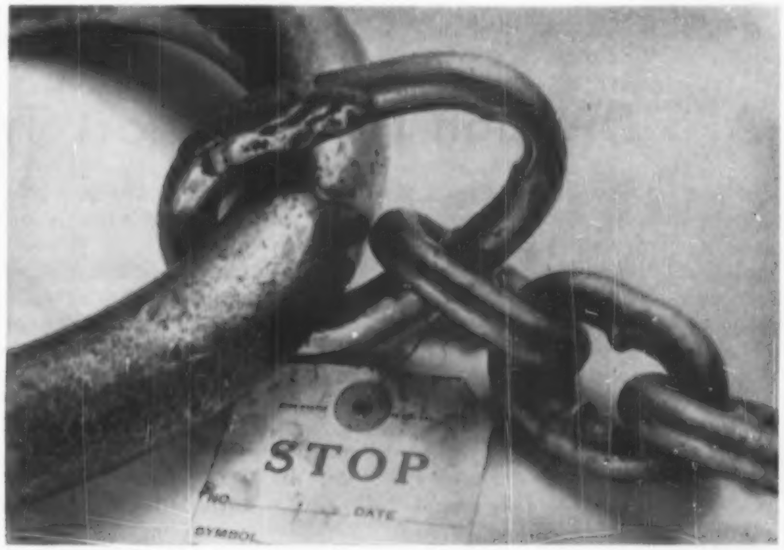

Fig. 10 . . Badly worn link shows that chain was in service long after it needed repair and indicates need of periodic inspection.

Fig. 11 . . Periodic inspection and elimination of practice of dragging chains over abrasive floors will prevent link flattening.

Fig. 12 . . Link has lost about 10% of its section and strength through prolonged dragging over concrete or hard surface floors.

Attending the 1956 meeting of the AFS Technical Council were (seated clockwise): J. H. Lowe, M. Tilley, F. B. Rote, H. F. Taylor, H. C. Ahl, Jr., C. K. Donoho, O. Jay Myers, J. W. Costello, J. E. Foster, E. C. Zirzow, B. L. Simpson, and W. J. Hebard. Standing (left to right) are: H. J. Weber, W. N. Davis, Wm. W. Maloney, C. M. Adams, Jr., C. G. Fuller, H. Bornstein, G. W. Anselman, K. M. Smith, W. R. Jaeschke, F. T. McGuire, W. H. Ruten, M. E. Brooks, H. J. Heine, E. Welander, and H. F. Scobie.

AFS Division Heads Chart Technical Course

■ Officers of technical divisions and committees of the American Foundrymen's Society met in Chicago June 7 to review activities of the past year, to make recommendations for future activities, and to prepare for the 1956 Annual AFS Convention slated for Atlantic City May 3-9.

Presiding at this meeting of the Technical Council (formerly called Technical Correlation Committee) was Manley E. Brooks, Dow Chemical Co., Bay City, Mich.; AFS President Bruce L. Simpson, National Engineering Co., Chicago, was co-chairman.

Decisions on the forthcoming convention included scheduling not more than three simultaneous technical sessions to minimize conflicting interests. Sessions will be of 2½-hr duration—9 to 11:30 am and 2:30 to 5 pm. All Shop Courses will be held in the evening.

Authors' Breakfasts, which were so popular at Houston, will be held each morning in Atlantic City.

Among technical developments of the past year is the organizing of a joint committee on welding gray, nodular, and malleable iron castings in the course of fabrication, reclamation, and salvage. Members of the American Welding Society and AFS are participating. Welding of other metals will be considered when this committee is successfully under way.

The Malleable Division is organizing a Pearlitic Malleable Committee to correlate technical information of pearlitic malleable iron producers.

Another new committee in process of organizing is the Intra-Industry Coordination Committee of the Brass and Bronze Division. They will cooperate with trade associations in the dissemination of technical information on product development.

A major development in the Sand Division is the new Basic Concepts Committee primarily concerned with studying fundamentals of foundry sand—its composition, properties, and use. Emphasis is placed on thinking out ideas which will then be given to appropriate committees to study application aspects.

Time and Motion Study for the Foundry, published this past year, fulfills one of the prime goals of the Industrial Engineering Committee (the old Time Study and Methods Committee).

The Educational Division's Committee on Foundry Curricula for Schools has been reorganized in the light of more immediate objectives from the Committee on Recruitment of Foundry Instructors.

A survey on chill measurement, resulting in clarifying revisions in items 5 and 9 of Amercan Society for Testing Materials' tentative specification A367-53-T, was reported by the Chill Test Committee of the Gray Iron Division.

Completion of the investigation of hot tearing of steel castings by Armour Research Institute was announced by the Research Committee of the Steel Division.

A color-sound film on vertical gating has been made available by the Research Committee of the Light Metals Division. Research on fluid flow and gating practices at Battelle Memorial Institute have been sponsored, this past year, jointly by Frankford Arsenal and AFS. The research continues previous work on horizontal gating systems summarized in another color-sound film, also available through AFS.

Attending this year's Technical Council meeting were:

Brass & Bronze Division: *chairman*, Harry C. Ahl, Jr., National Bearing Div., American Brake Shoe Co., Meadville, Pa.

Education Division: *chairman*, William H. Ruten, Polytechnic Institute of Brooklyn, New York; and *past chairman*, W. J. Hebard, Continental Foundry & Machine Co., Chicago

Gray Iron Division: *chairman*, Charles K. Donoho, American Cast Iron Pipe Co., Birmingham, Ala.; *vice-chairman*, Frank T. McGuire, Deere & Co., Moline, Ill.; and *past chairman*, James S. Vanick, International Nickel Co., Inc. New York

Light Metals Division: *past chairman*, Manley E. Brooks, Dow Chemical Co., Bay City, Mich.

Malleable Division: *chairman*, Frank B. Rote, Albion Malleable Iron Co., Albion, Mich.; *vice-chairman*, Eric Welander, John Deere Malleable Works, Deere & Co., East Moline, Ill.; and *past chairman*, Milton Tilley, National Malleable & Steel Castings Co., Cleveland

Pattern Division: *chairman*, Joseph W. Costello, American Hoist & Derrick Co., St. Paul, Minn.

Sand Division: *chairman*, O. Jay Myers, Archer-Daniels-Midland Co., Minneapolis; *vice chairman*, Elmer C. Zirzow, Werner G. Smith Inc., Cleveland.

Steel Division: *vice-chairman*: James H. Lowe, Mid-Continent Steel Castings Corp., Shreveport.

Refractories Committee: *chairman*: Walter R. Jaeschke, Whiting Corp., Harvey, Ill.

Cupola Research Committee and Cast Metals Handbook Revision Committee: *chairman*, Hyman Bornstein.

Safety, Hygiene, and Air Pollution Control Steering Committee: *vice-chairman*, Kenneth M. Smith, Caterpillar Tractor Co., Peoria.

Casting Defects Handbook Revision Committee: *chairman*, George W. Anselman, Foundry Services, Rockton, Ill.

Professors Clyde M. Adams, Jr., and Howard F. Taylor, Massachusetts Institute of Technology, Cambridge, were guests.

Members of AFS staff present were: Wm. W. Maloney, general manager; Hans J. Heine, technical director; Joseph E. Foster, technical assistant; William N. Davis, exhibits manager; Herbert J. Weber, director of safety, hygiene, and air pollution control; Curtis G. Fuller and Herbert F. Scobie, managing director and editor, respectively, Modern Castings.

Gray iron breathes oxygen! Recent discovery explains why castings contain more oxygen than expected

Robert C. Williams
Battelle Memorial Institute

Harold W. Lownie, Jr.
Battelle Memorial Institute

Three of the irons were conventional flake-type irons while the fourth contained nodular graphite.

The oxygen content of the irons was measured by a standard vacuum-fusion method. This method involves the analysis of the gases evolved when a sample of iron is dissolved in a carbon-saturated iron bath at 3000 F with the entire system under a high vacuum. The sensitivity of the apparatus in which the analytical measurements were made was ±0.0001 weight per cent oxygen. Figure 1 shows the vacuum-fusion apparatus used for the oxygen analyses reported in this paper.

Test Procedures

Specimens for vacuum-fusion analyses were prepared by cutting the flat ¼-in. castings into approximately 5-gram segments. Each segment was grit blasted to remove surface contamination. From this time on the specimens were handled with tongs or rubber gloves to reduce the chances of contamination.

Two specimens of each iron were analyzed within 24 hr after casting to determine the oxygen content of the freshly cast irons. The remaining specimens were stored under existing atmospheric conditions in a laboratory drawer and a specimen of each iron was analyzed at intervals of 1 week, 1 month, 3 months, 6 months, and 1 year. To remove any surface rust that might have formed during storage, each of the stored samples was thoroughly grit blasted again immediately before vacuum-fusion analyses.

It is important at this point to realize that a substantial amount of iron was blasted away in this cleaning operation immediately before analyzing. This was done to make sure that if any oxygen pickup was found, it could not be attributed to surface rusting but would have to be caused by penetration of oxygen into the specimen.

Vacuum-fusion analyses within 24 hr after casting showed that the oxygen contents of all the freshly cast irons were low and consistent with thermochemical predictions. The residual oxygen content of the three conventional flake-type irons ranged from 0.0024 to 0.0037 per cent while nodular iron contained only 0.0011 per cent oxygen. The lower residual oxygen in nodular iron was caused by the deoxidizing effect of the magnesium ladle treatment.

The increase in oxygen that occurred after each of these irons was exposed to average atmospheric conditions for periods up to 12 months is illustrated in Fig. 2. The amount of oxygen absorbed during any particular interval of storage was different for each iron. The conventional flake-type irons, No. 1, 2, and 3 in Fig. 2, absorbed oxygen quite readily during the period immediately after casting. Iron No. 3 exceeded the normal oxygen content (0.004 per cent) for irons of this chemical composition within one week. The other two flake-type irons exceeded 0.004 per cent oxygen shortly after 1 month of storage.

Graphite Flake Effect

Nodular iron did not abosrb oxygen as fast as the conventional flake-type irons. In view of the fact that the oxygen content of nodular iron after it was exposed to the atmosphere for 12 months increased to only 0.0025 per cent, the tendency for nodular iron to absorb oxygen appears to be very slight. This explains the improved resistance of nodular irons to oxidation and growth at elevated temperatures.

Study of the microstructure of each iron showed that the rate of absorption of oxygen depended upon the size of the graphite flakes connected to the surface of the casting. As the size of the graphite flakes connected to the surface of the casting increased, the amount of oxygen absorbed during a given interval also increased. The nodular iron absorbed very little oxygen, probably because few of the graphite nodules were connected to the surface of the casting. The size of the graphite flakes in each iron is shown in Fig. 3 (following page).

There was no correlation between the amount of oxygen absorbed and the chemical composition of the iron. While it is true that the size of the graphite flakes was dependent upon the composition of the iron, other factors such as pouring temperature and cooling rate also affected the graphite structure. For example, Fig. 3 shows that the chemical composition of Iron No. 3 was intermediate between those of Irons No. 1 and 2, yet Iron No. 3 contained the largest graphite flakes and absorbed the most oxygen during storage. The only factor that could be correlated with the rate of oxygen absorption was the size of the graphite flakes.

On the basis of the experimental evidence, gray cast iron can absorb oxygen when it is stored under average atmospheric conditions. Some high oxygen contents reported in the literature for gray irons undoubtedly occurred as a result of oxygen absorbed after the iron was cast. Because of the tendency for some gray irons to absorb oxygen rapidly, vacuum-fusion analyses for oxygen should be made as soon as possible after the iron is cast.

The mechanism of oxygen absorption is not known. It is possible that the increase in oxygen occurs as a result of (1) some form of oxidation in the areas around the graphite flakes connected to the surface of the iron or (2) oxygen adsorption on the graphite flakes.

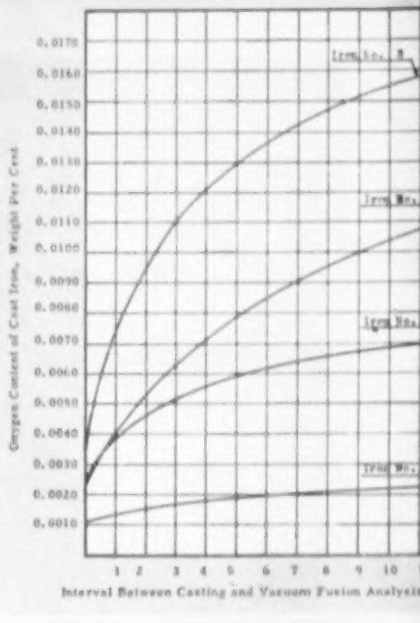

Fig. 2 . . Four irons absorbed oxygen at four different rates.

These ideas are merely speculative and should not be considered as proved. They are, however, based on a knowledge that:

1. A substantial increase in oxygen with time occurred only when there were graphite flakes that would allow easy passages for entry of air to the interior of the iron.
2. The diffusion rate of oxygen in solid iron is too low to account for oxygen entry by direct diffusion.
3. The increase in oxygen was accompanied by an increase in hydrogen in an amount which would be expected from the formation of hydrated iron oxide. These facts do not, however, rule out other possible mechanisms for the absorption of oxygen by cast iron.

Acknowledgment

The authors wish to express their appreciation to Messrs. M. W. Mallett, C. B. Griffith, and W. R. Hansen for their cooperation in performing the vacuum-fusion analyses.

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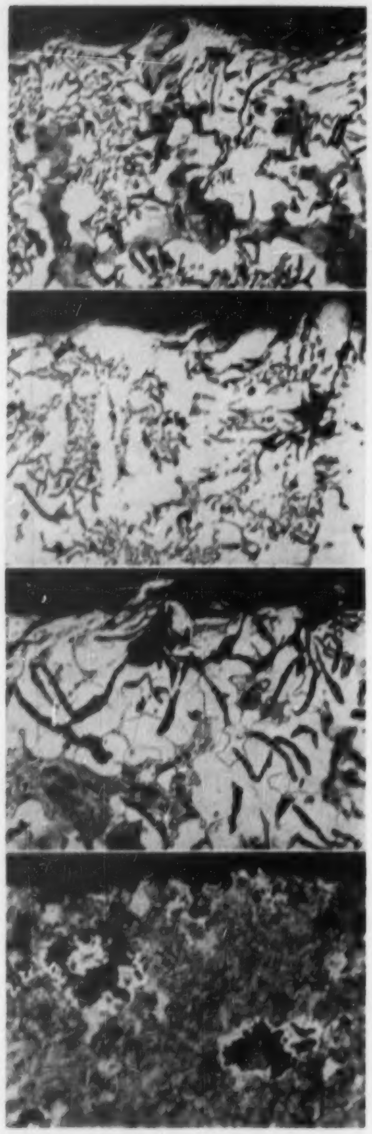

Fig. 3 . . Microstructures of irons used in test; from top to bottom irons 1, 2, 3, and 4. Photos approximately 250X.

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Seven Labs Probe pH Testing of Foundry Sands

Bradley H. Booth / *Fdry. Eng., Carpenter Bros., Inc., Milwaukee*

■ It all started as an American Foundryman Round Table on "pH of Foundry Sand", when great interest was shown in a comparison of pH tests with various types of pH meters on identical samples and according to procedures currently used by several laboratories.

As a result of a study among Round Table participants, it appears that pH tests seem to be reasonably reproducible; however, results could probably be improved with standard testing procedures. Their value in the foundry is still a matter of opinion, though results indicate pH control may prove to be valuable, particularly when more data are accumulated.

A sample of Carpenter Brothers distilled water in a bottle and samples of western bentonite and a steel foundry facing sand, each in a separate, new, metal can were taken to the several labs to be tested on the same day. Five steel foundries, a gray iron foundry, and an independent testing lab referred to as *A* through *G*, participated in the study which is summarized in the table.

Here is a brief description of equipment and procedures used for pH testing at each lab:

Lab A. *Equipment*—pH meter *W*, battery operated, temperature controlled, buffered at pH 7. *Procedure*—Samples were prepared in paper cups with water from the lab still, and stirred with a glass rod.

Lab B. *Equipment*—pH meter X, operated from line voltage, glass-calomel electrodes, no temperature adjustment, buffered at pH 5. *Procedure*—Samples were prepared in glass beakers with boiled Roxo distilled water, and stirred with a glass rod, then allowed to stand 30 min before testing. The bentonite sample was prepared in a malted milk-type mixer.

Lab C. *Equipment*—pH meter *W*, battery operated, glass-calomel electrodes, temperature control set at room temperature. *Procedure*—Samples were prepared in paper cups with water from the lab still, and stirred with a glass rod.

Lab D. *Equipment*—Universal Indicator *Y*. *Procedure*—Samples were prepared in glass beakers with water from the lab still, and stirred with a glass rod. Then about 20 ml of solution were transferred to test tubes for pH determination. A few drops of indicator were added to establish definite color, pH was then estimated by comparing the sample with a standard color chart.

Lab E. *Equipment*—pH meter *W*, battery operated, glass-calomel electrodes, temperature control set at room temperature, buffered at pH 10. *Procedure*—Samples were prepared in paper cups with water from the lab still, and stirred with a glass rod.

Lab F. *Equipment*—pH meter *Z*, operated from line voltage, glass-calomel electrodes, temperature control set at room temperature, buffered at pH 8. *Procedure*—Samples were prepared in 100-ml glass beakers with water from the lab still, and stirred by hand with a glass rod.

Lab G. *Equipment*—pH meter *W*, battery operated, glass-calomel electrodes, temperature control set at room temperature. *Procedure*—Samples were mixed in paper cups with Bethesda Waukesha distilled water, and stirred by hand with a glass rod.

Here's what the labs think of pH testing:

Lab A. pH test is used on research basis for checking bentonite, foundry sands, etc.

Lab B. pH test is used to control settling and penetration of core washes; seems to work best at pH of 6 to 6.5. Experiments with foundry sand indicate that additions of soda ash (in solution) to obtain a pH of 9.5 tends to improve flowability, finish, and reduce scabbing tendency.

Lab C. All green sand facing is made with pH controlled in the range of 9.5 to 9.7. Soda ash is added at the muller as dry powder. Sand flowability is better, there is less scabbing, and less burned-on sand in pockets.

Lab D. 102 lb of dry soda ash is added to each 300 lb of new sand facing to control pH at 8 to 8.5. There is less weld repair of surface defects on castings from this sand.

Lab E. pH control is used on new sand facing; 402 lb of dry soda ash is added to each 1000 lb batch of sand to hold pH at approximately 9.5. Sand flowability is better and there are fewer snotters; also about 1/8 less water is used—2.5 to 3.0 per cent water instead of 3.0 to 3.5 per cent.

Lab F. No correlation of pH and casting results has been found.

Lab G. A ratio of 2 to 5 (sand to water) has been found to be the minimum for consistent pH readings. Considerable research on pH control has not established any tangible benefits.

Test Amounts and pH Results from Seven Laboratories

	Type of	Carpenter Bros. Distilled Water			Western Bentonite				Steel Facing Sand				Lab H_2O Distilled	
Lab	Meter	ml	pH	°F	amt +	ml H_2O	pH	°F	amt +	ml H_2O	pH	°F	pH	°F
A	W	50	6.1	....	3.75 gr	50	9.9	....	20 gr	20	8.1	....	6.1	....
B	X	100	6.4	63	10 gr	100	9.4	81	50 gr	100	8.1	80	7.4[a]	75
C	W	50	6.2	66	5 gr	50	9.2	64	50 gr	50	7.8	65	6.5	64
D	Y	20	6.3	....	½ tsp	100	9.3	....	1 tsp	20	6.5	....	6.0	....
E	W	50	6.4	65	1 tsp	50	9.6	70	1 tsp	50	8.1	69	6.3	69
F	Z	30	6.4	71	5 gr	50	9.3	77	20 gr	20	7.8	76	5.8	75
G	W	25	6.7	60	1 tsp	50	10.2	60	25 gr	50	7.7	60	6.6[b]	60
Maximum			6.7				10.2				8.1			
Minimum			6.1				9.2				6.5			
Range (pH Units)			0.6				1.0				1.6			

[a] Boiled Roxo distilled water instead of lab distilled water.
[b] Bethesda Waukesha distilled water used instead of lab distilled water.

Honor 25-Year Members

Two new members of the Kirk & Blum Mfg. Co.'s "25-Year Club" were presented gold watches at the annual dinner meeting recently. Left to right, are, B. J. Wilke, new 25 year member; Edward Thierry, 48 years service, and L. H. Stortz, new member.

Name NFFS Committee Heads

Committee chairmen of the Non-Ferrous Founders' Society for the 1955-56 term have recently been appointed. They are: Membership, E. J. Metzger, Multi-Cast Corp., Wauseon, Ohio; Labor Relations, G. T. Fischer, Fischer Casting Co., Dunellen, N.J.; Cost, W. A. Gluntz, Brass & Aluminum Foundry Co., Cleveland; Insurance, R. Langsenkamp, Langsenkamp-Wheeler Brass Works, Indianapolis; Chapter Activities, C. J. Egetter, Crown Brass Mfg. Co., Los Angeles, and K. R. Proud, Anstice Co., Rochester, N.Y.; and Alternate Director, Elmer Brumund, Brumund Foundry, Inc., Chicago.

Fabricast Puts on a Show

The Fabricast Division of General Motors Corporation will have an operating exhibit at the General Motors "Powerama," to be staged on Chicago's lake front August 31 through September 25.

The "Powerama" is billed as the biggest show of its kind ever presented and will be open to the public in a 1 million sq. ft. area on the site of the Century of Progres exposition in 1933-34. Its aim is to dramatize the application of power to industry.

The Fabricast Division, one of nine GM manufacturing divisions to have exhibits at the Powerama, produces aluminum castings for diesel engines.

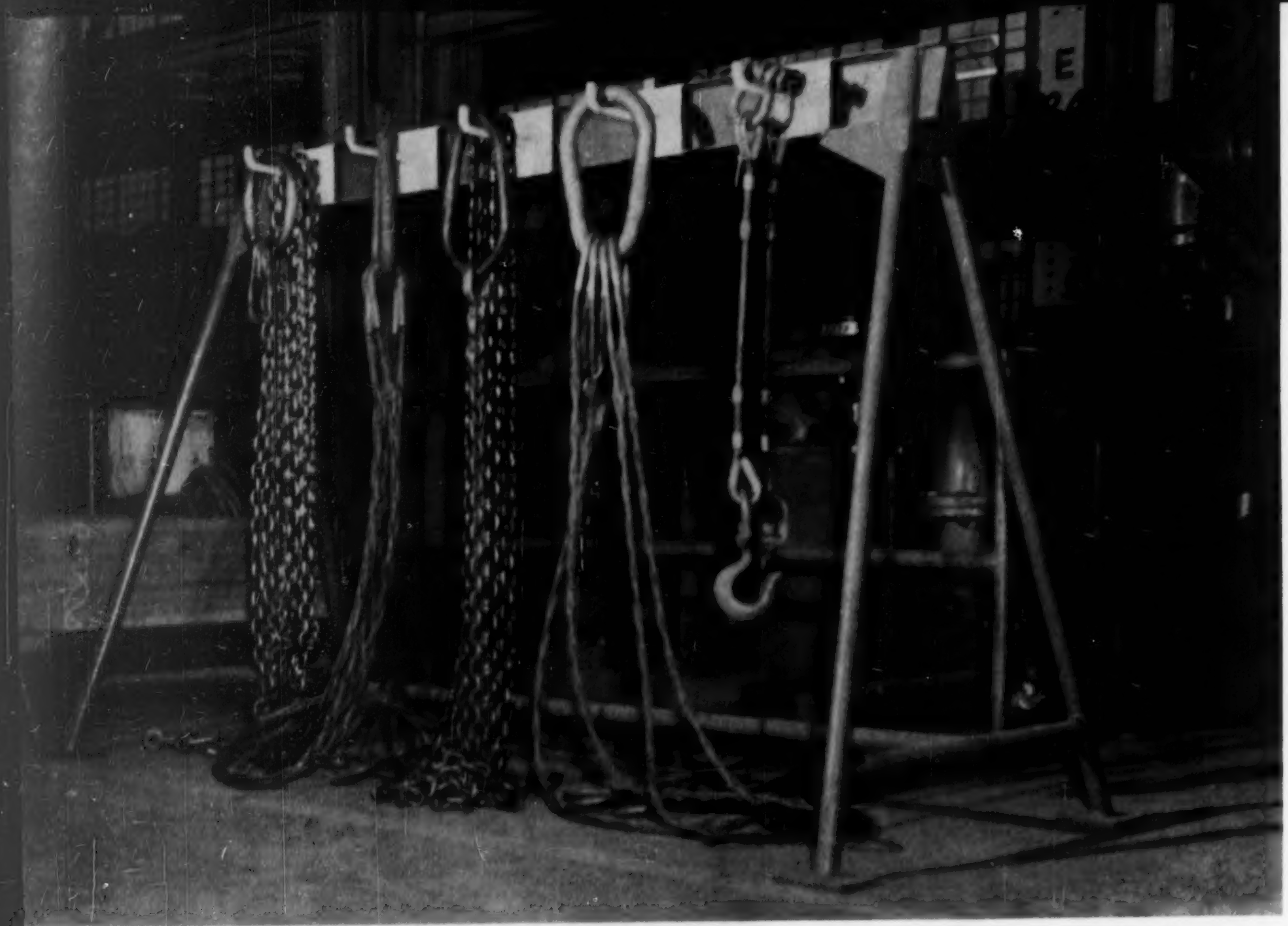


Fig. 1 . . Storage rack of hoisting equipment has availability and improves department housekeeping.

Jess Hogans/*Safety Director*
Fairbanks, Morse & Co.,
Beloit, Wis.

NO CHAIN FAILURES IN THIS FOUNDRY

Have chains and slings been giving you fits? Here's a standard procedure for procuring, inspecting and maintaining them

■ Potential danger of chain failure accidents may be overlooked or minimized because frequency of such accidents is low. Many plants or departments may go years with no chain failures.

There is nothing minor, however, about the probable severity of injuries or damages due to chain failure. When they occur, chain failure accidents usually are spectacular and serious. Fatal injuries may well be the rule rather than the exception when a chain or any piece of hoisting equipment fails and a load drops.

The serious injury potential of suspended loads is great enough to merit the serious consideration of all people concerned with accident prevention — plant management, departmental supervision, safety directors, and employees whose work brings them in contact with this hazard.

In our Beloit works we have 93 electrically operated overhead cranes. These operate constantly within the various departments of the shop and foundries carrying loads in varying sizes, weights, and shapes. Each of these loads is suspended by steel cable sling, steel alloy chain sling, or some lifting device.

Some of the castings with mold weigh as much as 60 tons. A locomotive assembly weighs as much as 130 tons. Crane operators are instructed not to carry loads over workmen. Employees are instructed not to work under, stand under, or even walk under suspended loads. But, we cannot leave the responsibility there. Management has a responsibility too, and an even greater one—to provide and maintain safe lifting equipment.

This is done by following a procedure covering the procurement, inspection, and maintenance of chain lifting devices. This procedure, written up as a standard practice, covers the steps to follow when a need develops for a new chain, for repairing a worn one, or for inspection regularly before use or periodically thereafter.

Writing up chain maintenance as a standard practice or production standard has been a factor in making safety progress. Spelling out responsibilities, explaining uses and methods to follow, clears up misunderstandings and helps give direction to the program. Our over-all plant safety program is written up as a production standard and is concrete evidence to all supervision and others that *safety is a part of production.*

Guilty or Not Guilty?

■ Do you use the wrong size or wrong type of chain sling for the job? Do you use slings too short for the load so that chain safe at 45° is overloaded and unsafe because it is being used at 30°?

■ Do you ignore the center of gravity in making lifts?

■ Do you hook up loads insecurely or force a hook into an opening in such a way that the load is carried on the point rather than the bottom of the hook? (Unless a hook is especially designed to carry the load toward the point, set the load in the bowl of the hook.)

■ Do you take chances by working or walking under suspended loads? (Why worry—haven't had one drop on you yet!)

When a need for additional lifting equipment in any department arises, the ordering procedure (Fig. 2) calls for the foreman of the department to make out a request on a maintenance service form. The request form covers a full description of the equipment needed, including a statement of the weights to be lifted.

The request is then sent to the plant engineering department for the preparation of drawings and specifications. Prior to their preparation, the chain engineer, who reports to the plant engineer, investigates conditions and discusses the requirements at the job and with the supervisor who made the request.

The plant engineering department then prepares the necessary drawings, showing complete dimensions, material, and heat treatment for all parts. The completed drawings are again checked and approved by the chain engineer and the department which placed the order.

The chain engineer next determines whether the equipment needed will be purchased outside or fabricated in the plant. Nature of the problem, special equipment, urgency of need, are some of the factors considered.

Some of the requests for chain assembly units are purchased complete from chain manufacturers. In this case, we follow the steps shown on the left side of Fig. 2.

When the equipment ordered is received from the chain manufacturer, the chain engineer checks the chain to see that it conforms to the specifications on the drawing. Following a proof test (Fig. 3 and 4) the chain engineer places a metal identification tag on the chain and completes an individual chain record card.

After a final check, the chain or equipment is delivered to the department where the supervisor signs the chain record card (Fig. 5) and the equipment he requested is ready for use.

The right side of the chart shows the steps followed when the equipment requested is to be fabricated in the plant. We purchase and maintain a stock of nickel alloy steel chains in bulk. Also an inventory of steel alloy hooks. Assemblies made at the plant are built from this stock of purchased parts.

When the chain engineer makes the decision to fabricate the chain at

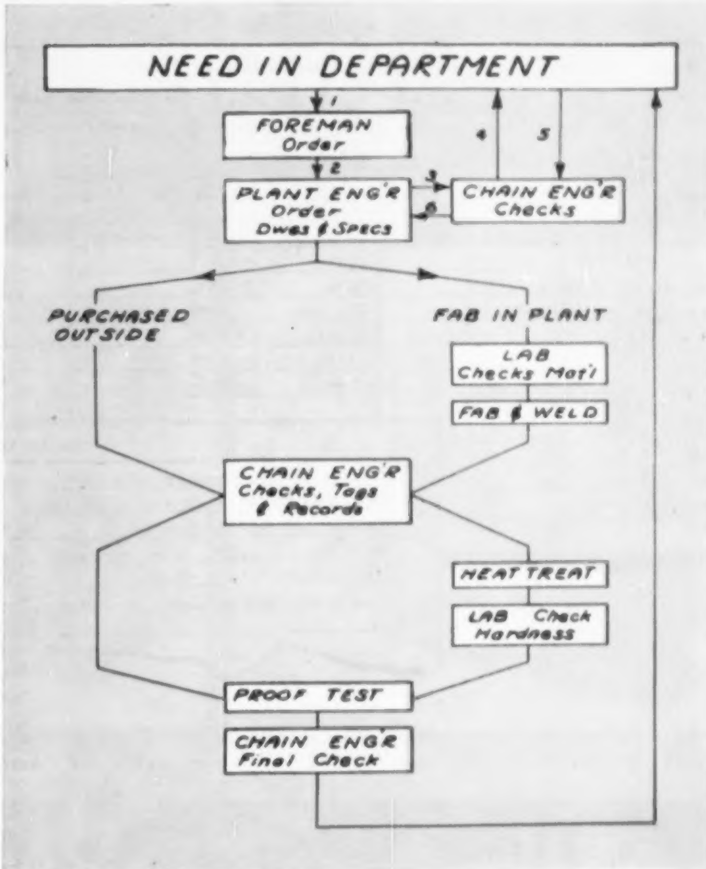


Fig. 2 . . Chain ordering procedure including specs and checks shows how chains are purchased or fabricated in the plant.

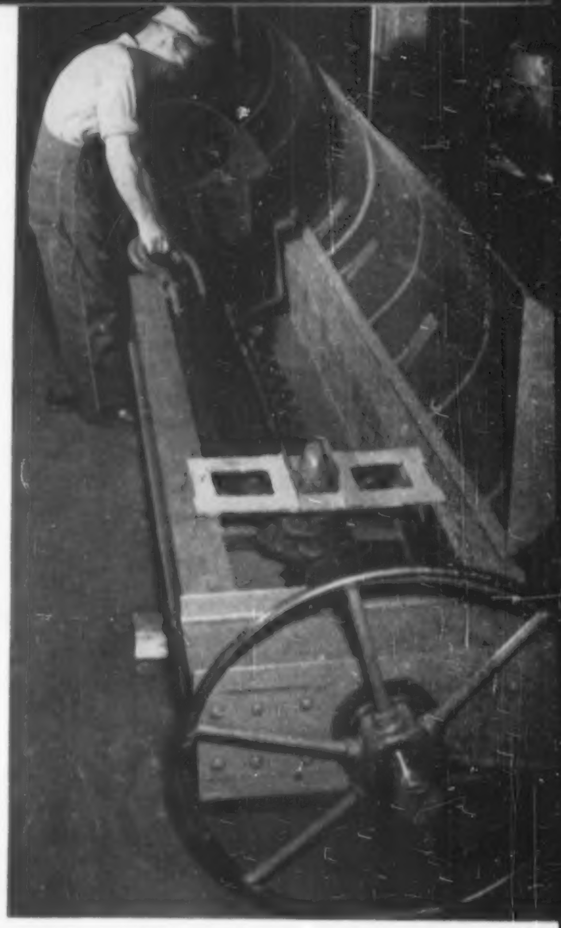
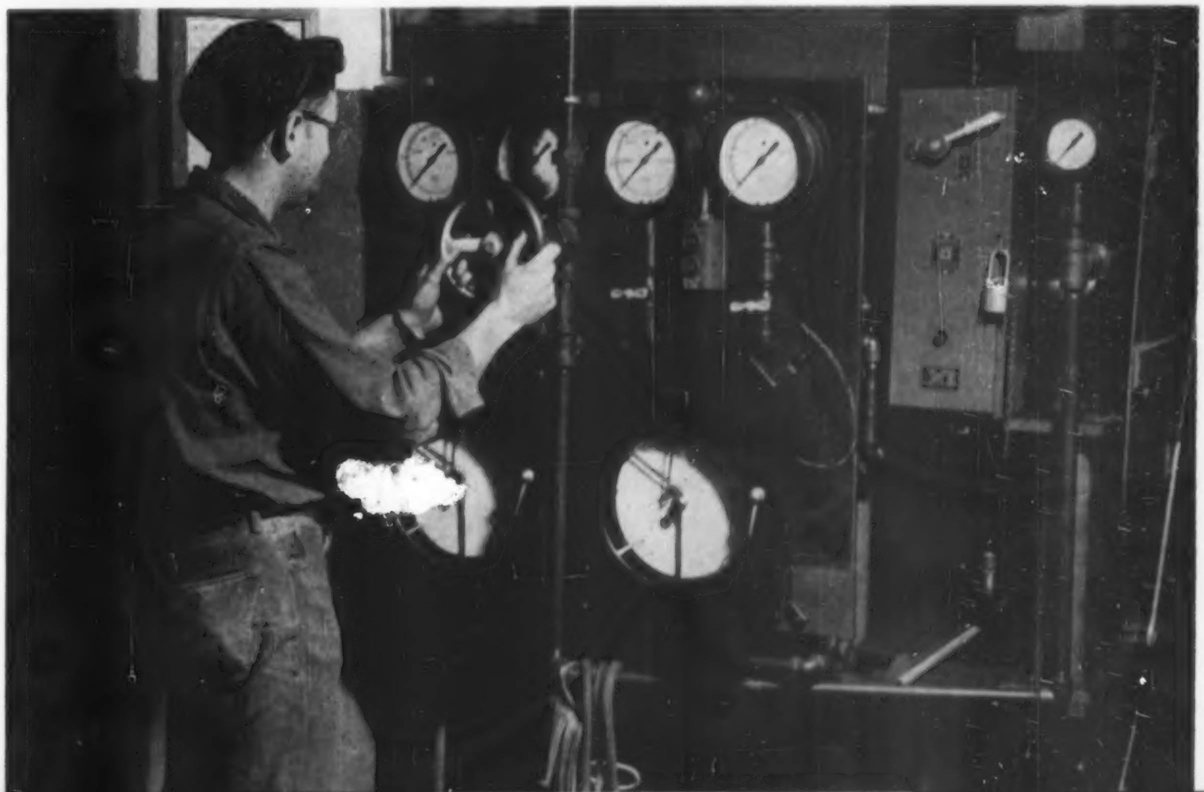


Fig. 3 . . 30-ft hydraulic pull test unit has remote controls.

Fig. 4 . . Operator slowly applies proof load to chain in pull test; load is released upon reaching the limit. Two lower dials of this control panel located about 10-ft from test unit record conditions.



the plant, samples of all materials to be used are checked by the laboratory to see that they conform to the chemical requirements specified. After approval by the laboratory, the forge shop assembles the chain components. They do not weld the connecting or joiner links; such parts of the chain assembly are welded by the chain service department under the personal supervision of the chain engineer (Fig. 6).

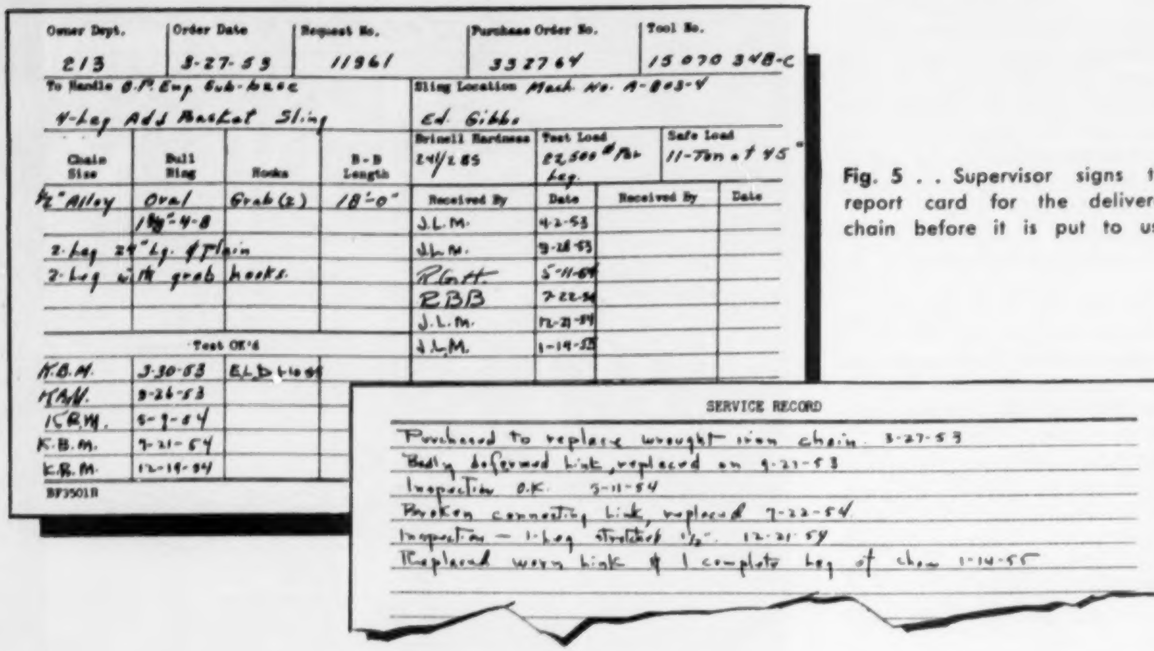
The chain assembly is then checked against drawings and specifications, and sent to the heat treat department. Following heat treatment, the laboratory checks hardness. We never return to production any equipment repaired by welding until it has been heat treated and tested for hardness. This is in addition to the proof test.

Next step is to send the chain to the chain service department for proof test. We follow the recommendations of the chain manufacturer as to proof loads. After the test, the chain is given a link by link visual inspection to locate those rare cases in which a chain may pass a proof test but still have a cracked link (Fig. 7), an elongated link (Fig. 8), or perhaps a hook that has developed defects while under test.

We then attach a stainless steel identification tag to the chain. This identifies the chain, its department, its safe load rated at a 45° angle, and date of inspection. The chain number is stamped on the bull ring so that the chain can be identified if the tag is lost.

After the chain record card has been completed, and prior to delivery to the department, a final check is made to see that the chain is tagged, bull ring stamped with chain number, and the records completed. The chain is then delivered to the department in which it belongs.

We have in service about 1500 pieces of chain or other hoisting equipment to which a hook is attached. Our program calls for periodic inspection of this equipment. Three men take about eight months to complete a cycle of inspection. The procedure for this periodic inspection covers the steps shown on the right side of Fig. 2 with the exception that no work order is required to authorize the inspections. This routine of periodic inspections is the major part of the chain service department's work.


Owner Dept. 213
Order Date 3-27-53
Request No. 11961
Purchase Order No. 332764
Tool No. 15 070 348-C
To Handle G.P. Eng. Sub-base
4-Leg Adj Basket Sling
Sling Location Mach. No. A-803-4
Ed. Gibbs
Brinell Hardness 241/285
Test Load 22,500 # Per Leg.
Safe Load 11-Ton at 45°
Chain Size ½" Alloy
Bull Ring Oval 1¾"-4-8
Hooks Grab (2)
B-B Length 18'-0"
2-Leg 24" Lg. & Plain
2-Leg with grab hooks.
Received By / Date
J.L.M. 4-2-53
J.L.M. 9-28-53
R.Gott. 5-11-54
RBB 7-22-54
J.L.M. 12-21-54
J.L.M. 1-19-55
Received By / Date
Test OK'd
K.B.M. 3-30-53 ELD 1-10-55
K.A.M. 9-26-53
K.B.M. 5-9-54
K.B.M. 7-21-54
K.B.M. 12-19-54
BF3501B

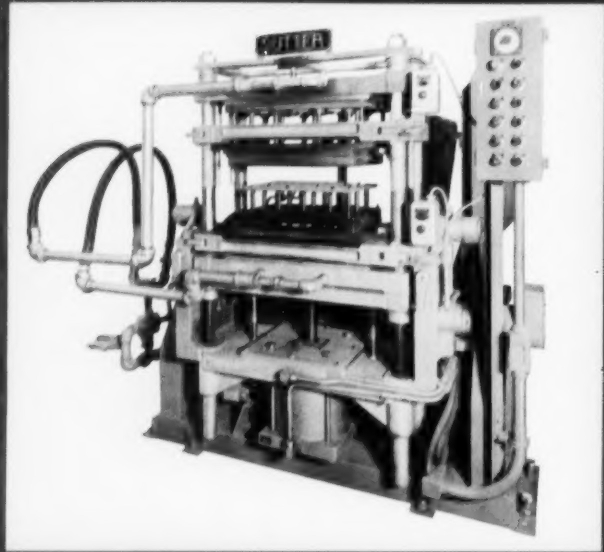
SERVICE RECORD
Purchased to replace wrought iron chain 3-27-53
Badly deformed link, replaced on 9-21-53
Inspection O.K. 5-11-54
Broken connecting link, replaced 7-22-54
Inspection — 1-leg stretched ½". 12-21-54
Replaced worn link & 1 complete leg of chain 1-14-55

Fig. 5 . . Supervisor signs the report card for the delivered chain before it is put to use.

Fig. 6 . . Forged chain components are welded by the chain service department under the personal supervision of the chain engineer. Atomic hydrogen welds are clean and sound in all types of chains.

SEE OTHER SIDE

An Automatic SHELL MOLD *Blowing Machine, Too!!*



Shown here is the Sutter SP-1300 set-up for shell molding. After curing, the box opens and stripper pins lift the completed shell mold from the pattern for quick, easy removal. Cycle is ready to repeat.

Shown here are typical cores and shell molds that have been produced on the new Sutter SP-1300. Production can be switched from cores to shell molds easily and quickly thus providing a truly double-duty investment.

Specifications:

Maximum Box Size..........14" x 24" x 7"

Maximum Draw........................7"

Maximum Core or Mold Weight.......16 lbs.

Production...........50-90 cycles per hour

Shell molds produced on this machine are as accurate on the *outside* as the inside. With this method of production, thickness is accurately controlled making it practical for mechanical back-up during pouring. Sutter shell molds are also ideal for stack molding.

In addition to extreme versatility, these Sutter Automatic Shell Core and Shell Mold Blowing machines feature simplicity of design, rugged construction and the famous built-in dependability characteristic of all Sutter foundry equipment.

For all the facts and figures, send for your free bulletin SP-1300.

DO-40M-455

Creators of foundry equipment with NEW productivity

LITHO IN U.S.A.

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2008 WESTWOOD AVE. • DEARBORN, MICHIGAN

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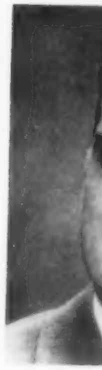
Exclusive Canadian and Overseas Manufacturer and Distributors

FOUNDRY EQUIPMENT LTD., LEIGHTON BUZZARD, BEDFORDSHIRE, ENGLAND

continu

G. E.

George E at Rockw water mo Pa., for transferre lyn wate manager.



J. W.

John W. S ed assistan R-P&C Val & Cable C merly serv tendent. M elected vic ing Found

C. Herbe sistant su

FOR MORE FA

let's get personal

continued from page 23

G. E. O'Brien . . Rockwell mgr.

George E. O'Brien, factory manager at Rockwell Mfg. Company's new water meter plant at Uniontown, Pa., for the past year, has been transferred to the company's Brooklyn water meter plant as foundry manager.

J. W. Swengel . . promoted

John W. Swengel has been appointed assistant works manager of the R-P&C Valve Div., American Chain & Cable Co., Reading, Pa. He formerly served as foundry superintendent. Mr. Swengel was recently elected vice-president of the Reading Foundryman's Association.

C. Herbert Quick, formerly assistant superintendent, Plant 2,

For more facts, circle No. 70 p. 81-82

chief inspector and engineer of ceramic development, Norton Co., Worcester, Mass., has been appointed assistant to the director of research and development.

H. J. Knudten . . Pettibone v-p

Herbert J. Knudten, president of Universal Engineering Co., Cedar Rapids, Iowa, has been elected vice-president of the concern's parent company, Pettibone Mulliken Corp., Chicago. Knudten, a native of Chicago will continue in his present capacity at Universal and maintain residence at Cedar Rapids.

Personnel changes and reassignments in the Central Office staff of the American Foundrymen's Society recently announced include:

C. G. Fuller, named managing director of MODERN CASTINGS AND AMERICAN FOUNDRYMAN. **H. F. Scobie** continues as editor.

W. N. Davis, who has directed the Safety, Hygiene and Air Pollution Control Program for several years, named manager of exhibits effective August 1, to replace A. A. Hilbron, resigned. Davis will be in charge of the 1956 AFS Exhibit.

H. J. Weber, named director of the SHAPC Program.

Recently editor of the Market Data & Directory Number of *Industrial Marketing,* Fuller has been editorial consultant to a number of magazines. After four years of newspaper work in Wisconsin, Evanston, Ill., and Chicago, he served as Wisconsin state information director for a year, then joined the staff of *Better Roads* magazine where he was associate editor for four years. One of his assignments was a re-

continued on page 73

Air Pollution Ordinances

▪ What do you know about the provisions of air pollution control ordinances in your area? Do you have one? Does your neighboring city? How does yours compare with others in the United States and Canada? The Accompanying table gives you these answers and helps you tackle your air pollution problem.

Most air pollution control codes deal with visible emission and were originally set up to control coal-burning equipment. And most foundry operators can comply with visible emission requirements, except during furnace light-up. Normal cupola operation, however, may not comply with emission opacity requirements of some codes.

Foundries are often unjustly singled out as major contributors to the over-all air pollution problem. On the other hand, there is a control problem, and foundrymen must contribute personally to the incorporation of technical provisions into contemplated codes that consider land usage, meterology, and topography, and that allow economically feasible compliance with the law.

In areas where no atmospheric-pollution ordinances have yet been enacted, or rather limited codes are in effect, the plant operator must decide whether to install moderately efficient control equipment or equipment which will meet the requirements of any foreseeable future atmospheric-pollution law. He must gamble the cost of less expensive installations which may later be scrapped, against a greater initial investment in high-efficiency equipment. Good intentions evidenced by the actual installation of at least medium-efficiency air-pollution-control equipment should reduce the likelihood of immediate liability for a reasonable time.

The table of code provisions together with ordinance symbol explanations on the next page is based on "The Cupola Emission Problem and Its Solution," by Aubrey J. Grindle, taken from Control of Emissions from Metal Melting Operations. Published by the American Foundrymen's Society, the book may be purchased for $1.50, members; $2.25, non-members.

Air Pollution Control Ordinance Provisions

Area	Date	Smoke and/or Nuisance	Fly Ash and/or Nuisance
Ala., Birmingham	1947	U3 N	N
Ark., Little Rock	(a)	N	N
Calif., Burbank	(a)	N	N
Los Angeles Co.	1951	R1 N	••17 N
Oakland	(b)	N	N
San Diego	1937	R3 N	N
San Francisco	1925	R3 N	N
Colo., Denver	1948	R1 N	N
Conn., Hartford	1937	R3	..
New Haven	(b)	N	N
Dela., Wilmington	....	R1	..
Fla., Jacksonville	1945	N	N
Miami	....	R1 N	N
Ga., Atlanta	1941 (c)	R3 N	•3 N
Ill., Chicago	1952	R2 N	N
Cicero	1951	R1 N	•13 N
Evanston	1930	D.S.	..
Peoria	1947	G.E.	..
Rockford	1949	N	N
Ind., East Chicago	1950	R2 N	•6 N
Evansville	1949 (c)	R2	..
Fort Wayne	1942	R2 N	N
Gary	1917	D.S.	N
Indianapolis	1951	N	•16 N
South Bend	(b)	N	N
Terre Haute	1947	R2 N	•5 N
Iowa, Davenport	....	R1 N	•2&6 N
Des Moines	(c)	R2 N	N
Kans., Topeka	(a)	N	N
Wichita	1921	D.S.	..
Ky., Jefferson Co.	(c)	..	..
La., New Orleans	....	N	N
Me., Portland	1949	R1 N	N
Md., Baltimore	1939	R1 N	•15 N
Cumberland	1947	R1	•15
Hagerstown	1948	R1	•15
Mass., Boston and 31 near-by towns	1934	R1	..
Chicopee	....	N	N
Springfield	....	D.S.	..
Mich., Dearborn	1950	R1 N	•10 N
Detroit	1947	R1 N	•10 N
Flint	1917	D.S.	..
Grand Rapids	1926	R2 N	N
Highland Park	1948	R1 N	•10 N
Lansing	1952	R1 N	..
Muskegon	1937	D.S. N	..
Minn., Duluth	1931	R2 N	..
St. Paul	1949	R1 N	•5
Mississippi, Jackson	....	N	N
Mo., Jefferson City	1945	R1 N	N
Kansas City	1948	R2 N	N
St. Louis	1948	R1 N	•7 N
University City	1941	R1 N	N
Neb., Omaha	1947	R1 N	•5 N
N. J., Camden	1947	R2 N	N
East Orange	1948	R1 N	N
Hackensack	....	D.S. N	N
Montclair	1925	D.S. N	N
Newark	1938	R2 N	N
Trenton	....	D.S.	N
N. Y., Buffalo	1947	R2 N	N
Elmira	1949	R1 N	..
Kingston	1949	D.S. N	N
New York	1952	D.S.N.	•18 N
Niagara Falls	1947	R1 N	•2&5 N
Poughkeepsie	1951	R1 N	•8N
Rochester	1947	R2 N	•6 N
Schenectady	1950	R3	..
Syracuse	1948	R1 N	•2&5 N
Tonawanda	1953	R2 N	•14 N
Utica	1949	R1 N	•15 N
White Plains	1947	R1 N	N
Yonkers	1950	R1 N	N
Ohio, Akron	1947	R2 N	•5 N
Cincinnati	1952	U3 N	•2&6 N
Cleveland	1951	R1 N	•12
Columbus	1949	R1 N	•5 N
East Cleveland	1941	R1 N	N
Hamilton	....	D.S. N	..
Toledo	1950	R1 N	•5 N
Warren	1939	R1 N	N
Youngstown	1950	R1 N	•15 N
Ore., Portland	(b)	..	..
Pa., Erie	1951	R1 N	N
Harrisburg	1921 (c)	R2	..
Philadelphia	1949 (c)	R2 N	•5 N
Pittsburgh	1951	R1 N	•11 N
Reading	1948	R2 N	N
R. I., Providence	1947	R1 N	•5
S. C., Columbia	1949	R2 N G.E.	..
Tenn., Chattanooga	1951	R1 N	N
Knoxville	(a)	R2 N	N
Memphis	....	R2 G.E.	..
Nashville	1947	R1 N	•15 N
Texas, Fort Worth	....	G.E.	..
Houston	1942	D.S. G.E.	..
Utah, Salt Lake City	1941	R2 N	N
Va., Danville	1953	R1 N	•2&6 N
Richmond	1951	R2 N	•9 N
Roanoke	1947	R3 N	•2&6 N
Wash., Spokane	....	D.S.	..
Tacoma	1951	R2 N	•2&6 N
Washington, D. C.	1935	D.S. N	N
Wis., Green Bay	1950	R1 N	•2&4 N
Madison	1953	R1 N	N
Milwaukee County	1948	R1 N	•5 N
Oshkosh	1950	R1	•2&5
CANADA			
Hamilton	1951	R1 N	N
Montreal	1950	R1 N	•5 N
Ottawa	1947	R2 N	•2&6
Quebec City	1941	R1 N	..
Toronto	1949	R2 E	•2&5 N
Vancouver	1948	R1 N	N
Windsor	1949	R1	•2&6

Ordinance Symbol Explanations

Date refers to the year of adoption of the basic code or its most recent revision.

(a) Smoke regulations incorporated in city health code.

(b) Proposal ordinance, not yet formally approved.

(c) Ordinances now being amended.

Third column indicates the maximum continuous amount of smoke permitted, indicated by reference to the Ringlemann Chart and by symbols *N* to any additional control ordinance which covers only nuisances caused by the emission of fumes, gases, vapors, metallic oxide, etc.

D.S. refers to Dense Smoke where a definite method of measurement is not indicated. Practically all ordinances provide for the emission of darker smoke for short periods in each hour during blow-down, cleaning periods, etc.

E.–Toronto foundries and some other industries are exempt from the local air pollution control ordinance.

G.E.–general engineering specifications showing sizes of combustion chambers, heights of stacks, etc.

N–nuisance clause where the emission of dust, fumes, and smoke is a general nuisance; in some cases a restriction in addition to the specified amounts that may be emitted legally.

R1, R2, R3 indicate the amount of smoke permitted by comparison to the Ringelmann Chart.

U–Umbrascope in which one thickness of 60% opacity glass equals No. 1 scale, two thicknesses equal No. 2 scale, three thicknesses equal No. 3 scale, and four thicknesses equal No. 4 scale.

Fourth column indicates by symbol "*" the maximum amount of cinders, dust, or other particulate matter that may be emitted. *N* in this column indicates where a nuisance ordinance is the only control, or an additional control to the dust emission regulation. Various city ordinances define particulate matter, dust, and fumes as follows:

Cinders: Particles not ordinarily considered fly ash or dust because of their greater size, entrained in the products of combustion and consisting essentially of fused ash and/or unburned combustibles.

Dust and Fly Ash: Gas-borne or air-borne particles larger than one micron (approximately 0.00004 or 1/25,000 inch) up to 44 microns (325 mesh); many cities ignore the size, and place limits on the weight of material that may be emitted.

Fumes: Gases, vapors, metallic oxides, etc. that are of such character as to create an unclean, destructive, offensive, or unhealthful condition.

*1 to *18–Limits of emission of solids or particulate matter vary as follows:

*1–75% minimum collection.

*2–85% minimum collection.

*3–90% minimum collection.

*4–0.85 lb /1000 lb gas or air.

*5–0.85 lb /1000 lb of gas adjusted to 12% CO_2.

*6–0.85 lb /1000 lb of gas adjusted to 50% excess air.

*7–0.85 lb /1000 lb of gas adjusted to 50% excess air. Not more than 0.5 lb /1000 lb of gas shall be larger than 325 mesh.

*8–0.85 lb /1000 lb of gas adjusted to 50% excess air. Maximum 0.2 lb of dust larger than 325 mesh.

*9–2 lb /1000 lb of gases at 12% CO_2–must collect 75%.

*10–0.30 gr/cu ft at 500 F adjusted to 50% excess air.

*11–0.30 gr/cu ft at 500 F adjusted to 50% excess air; not to exceed 0.2 gr/cu ft larger than 325 mesh.

*12–0.425 gr/cu ft at 500 F adjusted to 50% excess air.

*13–0.75 gr/cu ft at 500 F adjusted to 50% excess air. Not more than 0.4 gr/cu ft shall be larger than 32 mesh.

*14–0.75 gr/cu ft at stack temperature, not more than 0.2 gr/cu ft retained on a 300 mesh U. S. Standard sieve. Excess air not to exceed 50% at full load.

*15–0.75 gr/cu ft at 500 F adjusted to 50% excess air. Not more than 0.2 gr/cu ft shall be larger than 325 mesh.

*16–0.75 gr/cu ft at 500 F and 50% excess air. Not more than 0.2 gr/cu ft (with gas at 850 F) shall be larger than 325 mesh.

*17–2% by volume SO_2. 0.40 gr/cu ft adjusted to 12% CO_2 except that dust or fumes may not exceed amounts shown in table of ordinance varying from 0.24 lb/hr with process weight of 50 lb/hr to 40 lb/hr with process weight of 60,000 lb/hr. Maximum permitted is 40 lb/hr regardless of process weight.

*18–For steam: 2.2 lb dust/1000 lb steam at 100,000 lb steam/hr to 0.8 lb dust/1000 lb steam at 1,000,000 lb steam/hr.

For other processes: 0.85 lb/1000 lb gas adjusted to 50% excess air. Not more than 0.40 lb/1000 lb of gas shall be larger than 325 mesh.

Pollution Book On Way

The Air Pollution Control Committee of the American Foundrymen's Society under Chairman Frank Patty, General Motors Corp., is presently compiling the AIR POLLUTION CONTROL MANUAL incorporating CONTROL OF EMISSIONS FROM METAL MELTING OPERATIONS.

Tentatively assigned sections of the Manual include:

Introduction to Air Pollution
Community Relations
Undesirable Emission Effects:
Odor and dirt nuisance; harmful effects on man, animals, vegetation, and property.
Sources of Foundry Pollutants:
Physical and chemical nature, rate, and amount of emission from *Melting*; *Molding*–mold drying, pouring, shakeout; Coremaking–baking, spraying, grinding; *Cleaning*–blasting, grinding, burning, powder washing, painting, welding, annealing; *Also*–materials handling, waste disposal, and power plant.
Sampling Procedures
Air Cleaning Equipment

Free Tear Sheets

of all MODERN CASTINGS articles are available on request. Keep your magazine intact and pass it on for others to use. For free tear sheets, write to Editor, MODERN CASTINGS, Golf & Wolf Roads, Des Plaines, Ill. Please show company connection and your title on tear sheet request.

Dr. G. H. Clamer . . 80 candles

W. N. Davis . . exhibits mgr.

H. J. Weber . . director of SHAPC

C. G. Fuller . . managing director

continued from page 70

search job that won the *Industrial Marketing* award as the best promotion accomplished by any industrial magazine that year.

In 1942, Fuller became associate editor of *Flying* magazine, serving successively as assistant managing editor, managing editor, and editor. For a number of years, he wrote the aviation section of the *World Book Encyclopedia Year Book*.

Davis has a background of 14 years as an industrial safety engineer and was senior engineer for the National Safety Council.

Weber became an AFS staff member after 12 years as chief industrial hygienist for American Brake Shoe Co. Formerly an instructor in chemistry and mathematics, he has an MS degree in chemistry from DePaul University and a civil engineering degree from Lewis Institute (now Illinois Institute of Technology). He is the author of many technical publications on industrial hygiene and edited the *American Industrial Hygiene Quarterly* for which he currently serves as advisory editor.

Dr. G. H. Clamer was honored on his 80th birthday with a luncheon at the Waldorf Astoria, New York, given by the Brass & Bronze Ingot Institute. President and general manager of Ajax Metal Co., now Ajax Electro Metallurgical Corp. and its affiliates, since 1920, Dr. Clamer pioneered in the chemical phases of the non-ferrous industry, and in the electric melting of non-ferrous metals, He has a number of inventions, including a refining process employing scrap metals for which he received the Elliot Cresson Gold Medal of the Franklin Institute in 1901.

Dr. Clamer is a charter and 50-year member of the American Electro-Chemical Society, one of the original American members of the British Institute of Metals, and a member of the Institute of Metals Div., American Institute of Mining and Metallurgical Engineers, He was president in 1914.

He is a past-president and 50-year member of the American Society for Testing Materials and was elected an honorary member in 1937. President of American Foundrymen's Society in 1923-24, he received the Joseph S. Seaman Gold Medal in 1933, and in 1946 he presented the Charles Edgar Hoyt Memorial Lecture of the Society.

He represents the Brass and Bronze Ingot Institute on Committee B-5 on Copper and Copper Alloys, Cast and Wrought.

Carl Beers, Birmingham, Mich., was appointed Detroit area sales representative for the Newaygo Engineering Co., Newaygo, Mich. Previous associations include, Chrysler Corp.,Dodge Main Plant, and vice-president and sales manager for the C. B. Schneible Co., both of Detroit.

Richard J. Green has been placed in charge of the newly established Southeast States Technical Field Section of the International Nickel Company's Development and Research Div., Atlanta, Ga.

Carl L. Liebau, executive vice-president, Federal Malleable Co., West Allis, Wis., was elected president-treasurer of the firm at a recent board of directors meeting.

Norman N. Amrhein, who has been secretary-treasurer, was elected vice-president-secretary. Change of officers was made necessary by the death of W. H. Heatley, who was president until his death March 19. Mr. Liebau has just been elected president of the Malleable Founders Society, Cleveland.

Claude B. Kershner, Phoenixville, Pa., has been appointed director of purchases for the Birdsboro Steel Foundry & Machine Co. He has been with the firm as purchasing agent since January 1951.

Link Belt Co., Chicago, has appointed three men to supervise distributor activities. **George L. Gansz**, operating from headquarters in Philadelphia, will be the representative for all distributors in the eastern states; **Albert A. Quinn**, operating from Chicago, will perform the same function for distributors located in the mid-western and southwestern states; and **Harold J. Guiver** will serve in a similar capacity on the West Coast, from headquarters in San Francisco.

C. L. Liebau . . Federal pres.

N. N. Amrhein . . v-p and secty.

R. J. Green . . in charge

C. Beers . . Newaygo rep.

9:18 am .. Pancho Gutierrez receives badge, U. Lopez Ayala stands by.

9:32 .. "Chapter success depends on leadership of the chairman" declares General Manager Wm. W. Maloney.

9:45 .. Regional Vice-President Bill Pindell introduces self during get-acquainted session.

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12th ANNUAL OFFICERS CONFERENCE

SETS PATTERN FOR LOCAL AFS ACTIVITIES

▪ Paced like a fast moving sales meeting with continuous activity and not a moment wasted, the 12th Annual Chapter Officers Conference of the American Foundrymen's Society was held June 16 and 17 at Hotel Morrison in Chicago and the AFS Technical Center in Des Plaines, Ill. Some 110 representatives of the 42 AFS chapters in the United States, Canada, and Mexico, and the New England Foundrymen's Association, joined with society officers, directors and staff members to review program planning and to get a refresher course on AFS services and policies.

Conference chairman was AFS President Bruce L. Simpson, National Engineering Co., Chicago. Assisting him were Frank W. Shipley, Caterpillar Tractor Co., and General Manager Wm. W. Maloney.

Conduct of the tightly scheduled meeting set an example, as in the past, for operation of chapter meetings with sessions starting on time and stopping on time even if it meant cutting a speaker off before the end of his comments.

Topics covered by AFS officers and staffers included the organization's technical program, the Safety & Hygiene & Air Pollution Control Program, the 1956 AFS Convention and Exhibit (Atlantic City May 3-9), chapter programs and educational activities, and organization of chapter operations and committees.

Between the late afternoon and evening session the first day, the conference had a light touch when a reluctant "chapter secretary" was induced to speak briefly at dinner. He turned out to be a professional speaker with a humorous, if meager, knowledge of castings production and chapter operation.

In the evening, regional meetings were held under the chairmanship of regional vice-presidents: Tom Kaveny, Jr., Herman Pneumatic Machine Co., Pittsburgh; Martin J. Lefler, Oliver Corp., South Bend, Ind.; C. V. Nass, Beardsley & Piper Div., Pettibone Mulliken Corp., Chicago; L. H. Durdin, Dixie Bronze Co., Birmingham, Ala.; and Wm R. Pindell, Northwest Foundry & Furnace Co., Portland, Ore.

Highlight of the second day was a trip to the new AFS Technical Center where sessions were held in the library after a tour of the building.

10:27 .. "No death-dealing dust:" new SHAPC Director Herb Weber.

10:42 .. After coffee break, intensive program continued unabated.

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11:22 .. Charlie Mooney, Len Greenfield, Fritz Strieter, Clayton Russell, and Charlie Fuerst tell how to develop chapter program.

1:40
with

9:49 .. "AFS is devoted to production and utilization of castings," explains President Simpson.

9:57 .. Technical Director Hans Heine acquaints listeners with broad endeavors of his department.

10:12 .. "You can cut accidents in half!" says retiring SHAPC Director Bill Davis.

12:10 pm .. Dick Oster, Ash Sinnett, and Earl Strick set sights on afternoon education session.

12:15 .. Conference program was kept on rigid time schedule but there was still time for a 75-minute lunch hour.

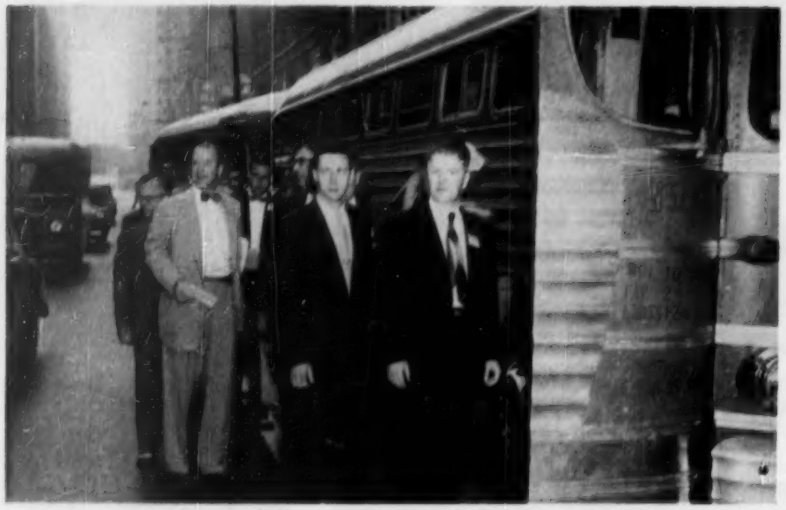
1:25 .. FEF has come a long way reports Executive Director Walsh.

1:40 .. Tom Kaveny (standing) confers with Hank Frechette and H. Stenberg.

2:05 .. "National director will visit each chapter," stated VP Shipley.

7:47 .. Bashful delegate had to be coaxed to speak, turned out to be a ringer, amused all including Jim Hewitt and Bruce Simpson.

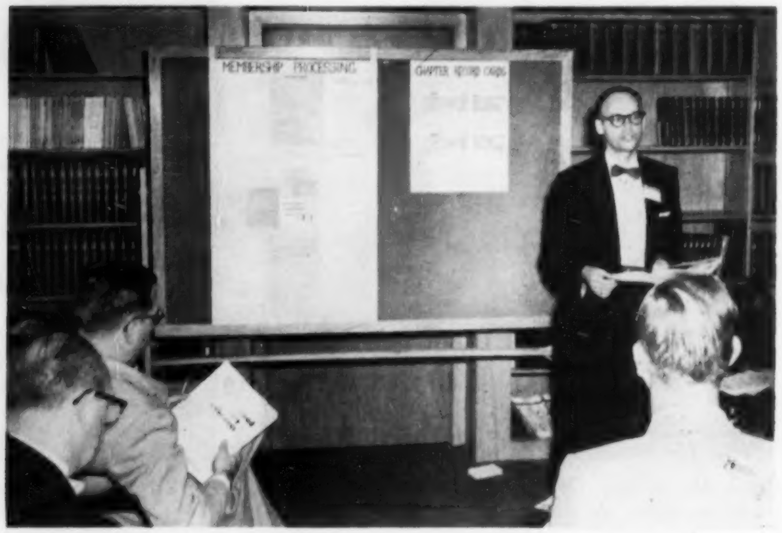
Visit AFS Technical Center second day



8:00 am Friday . . Conferees embark on air-conditioned buses for visit and more sessions in new AFS Technical Center.

9:00 . . Curt Fuller (left), managing director of MODERN CASTINGS, explains magazine's new look and broadened editorial content.

9:03 .. Greg Minogue (at desk) shows how he untangles MODERN CASTINGS production snarl, keeps operations running smoothly.



10:40 .. Herb Scobie, MODERN CASTINGS editor, tells how Editorial Board functions, gives preview of features in future editions.

Not on any definite schedule was examination of AFS publications.

Admiring new magazine format are Messrs. Smith, Menzel, Czyzewski.

Hold Delta Oil Sales Meeting

Delta Oil Products Co., Milwaukee, recently held a two-day sales meeting to advance the technical abilities of Delta representatives toward better service to an increasing number of foundry customers. Front row (left to right) are: R. L. Starek, R. P. Kumb, J. A. Gitzen, company president, J. A. Cormack, sales consultant, and R. A. Johnson. In the back (left to right) are: J. J. Lee, V. D. Gornick, E. A. Rathlesberger, S. W. Hinrichs, and Walter Napp.

Plan Broader Castings Research

Broadening of research on fundamental castings problems was the major subject for discussion when members of the Board Research Committee of the American Foundrymen's Society met June 27. Seated (left to right) are: E. C. Hoenicke, Foundry Div., Eaton Mfg. Co., committee chairman; G. Ewing Tait, Dominion Engineering Works, Ltd; and C. E. Nelson, Dow Chemical Co. Standing (left to right): Bruce L. Simpson, National Engineering Co., AFS president; Wm. W. Maloney, AFS general manager; and Hans J. Heine, AFS technical director.

Investment Casting Institute Joins Castings Council

Eleventh member of the National Castings Council is the Investment Casting Institute, which joined NCC recently.

Other members are: American Foundrymen's Society, Alloy Casting Institute, Foundry Educational Foundation, Foundry Equipment Manufacturers' Association, Foundry Facing Manufacturers' Association, Gray Iron Founders' Society, Malleable Founder's Society, National Foundry Association, Non-Ferrous Founders' Society, and Steel Founders' Society of America.

Copper-Base Casting Uses

Ten leading industrial uses of brass and bronze castings represent three-fifths of the total foundry shipments. Leading uses are: journal bearings; plain bearings and bushings; metal plumbing fixtures and fittings; valves, (except plumbing); railroad maintenance, repairs, and operating supplies; pipe fittings (except plumbing); plumbing valves, specialties; industrial pumps; integrating meters, nonelectrical; and high voltage switch gear. The list appears in a publication of market research interest to foundries, *Uses of Copper in Brass and Bronze Foundry Products,* available free from: Copper Div., Business and Defense Services Administration, U. S. Department of Commerce, Washington 25, D. C.

Issue Electrode Specs

Three new specifications covering tungsten arc-welding electrodes, stainless steel electrodes, and low-alloy steel electrodes, have recently been issued jointly by the American Welding Society and the American Society for Testing Materials.

The specification on tungsten arc-welding classifies the electrodes into four basic chemical analyses, thus enabling the user to select his tungsten electrodes by composition according to his requirements. Latter specifications covering stainless steel and low-alloy steel electrodes give details on test methods.

Copies of each specification may be obtained for 40¢ from the American Welding Society, 33 West 39th St., New York 18, N. Y.

Building Fund Still Growing

An additional contribution to the Headquarters Building Fund of the American Foundrymen's Society was recently received from John A. Wagner, president, Wagner Malleable Iron Co., Decatur, Ill. With the contribution, a total of $225,703.75 has been raised to construct this Society's Central Office building, dedicated in November, 1954.

During the recent Chapter Officers Conference, the Headquarters Building was visited and inspected by some 84 officers of the Society's chapters.

Program for Prosperity

National prosperity based on full production and increased productivity is the subject of a new study, *"So People May Prosper,"* published by the National Association of Manufacturers. The study advocates measures to permit or encourage growth of the nation's productive facilities as the pathway to high employment and a rising living standard.

This study, issued by NAM to help individual Americans decide on the courses of action that will bring continuing growth and prosperity, may be obtained for $1.00 by writing National Association of Manufacturers, 2 East 48th St., New York 17, N. Y.

Film Shows Flaw Location

"Flaw Location with Dye Penetrants" is the title of a new color-sound, 23-min. 16mm motion picture showing on-the-spot inspections in several metalworking plants.

A laboratory inspection is performed on glass micro-slides which have been fastened together to simulate a defect. In this sequence, the viewer is enabled to see exactly what action takes place when flaws are located in metal parts with dye penetrants.

Film is available for free showing to industrial concerns, technical groups and other interested organizations. Arrangements for viewing or additional information may be secured by writing Turco Products, 6135 South Central Ave., Los Angeles 1, Calif.

Malleable Founders annual banquet had at the head table (left to right): President-Elect C. L. Liebau, Mrs. Liebau, Mrs. C. E. Brust, Retiring President Brust, W. A. Kennedy, Mrs. L. J. Wise, and Vice-President-Elect Wise.

W. A. Kennedy (right), Grinnell Co., Providence, R. I., receives MFS McCrea Medal from Leon J. Wise, Chicago Malleable Castings Co.

Malleable Shipments May Set Record

■ Continued high level of malleable casting production for the balance of this year was predicted by Charles E. Brust, Eastern Malleable Iron Co., Naugatuck, Conn., in his presidential address at the annual meeting of the Malleable Founders' Society June 16-17 at the Greenbrier, White Sulphur Springs, W. Va.

"Such predictions are, of course, qualified by conditions in the automotive industry," Mr. Brust said, "but it is not unreasonable to anticipate production for the year on the order of 950,000 tons, an increase of about 15 per cent over 1954. March shipments were highest for any single month in history —102,364 tons. With the high level of business activity for the balance of the year predicted by some forecasters, total shipments could surpass the all-time high of 1,080,000 tons in 1951, he indicated.

Brust stated that pearlitic production had doubled during the past decade, and that the nearly 100,000 tons shipped in 1954 had been practically all new business.

Recipient of the McCrea Medal for distinguished service to the malleable iron industry was William A. Kennedy, Grinnell Co., Providence, R. I., for many years a member of the MFS Technical Council. During recent years when he has headed the council, research projects in gating and feeding of castings, and in core materials and practices have been carried on. In addition, he has done considerable work of his own on speed of testing, high and low temperature properties, and impact testing.

Leon J. Wise, Chicago Malleable Castings Co., presented the McCrea Medal to Mr. Kennedy at the annual banquet.

At a meeting of the board of directors of MFS, Carl L. Liebau, Federal Malleable Co., West Allis, Wis., was elected president. Mr. Wise was elected vice-president, and Dudley V. Walker, Eberhard Mfg. Co. Div., Eastern Malleable Iron Co., Cleveland, was re-elected treasurer. Lowell D. Ryan, Cleveland, was elected to another term as secretary and managing director.

Newly elected directors are: Richard E. Whinrey, Link-Belt Co., Indianapolis; Anthony Haswell, Dayton Malleable Iron Co., Dayton, Ohio; and Gardner Van Duyne, Meeker Foundry Co., Newark, N. J.

In outlining a program for 1955-56, Mr. Liebau placed particular importance on research and promotion. "We have a good product," he said, "and we must keep on telling the world that it is good and that it has a place in modern engineering and design." The Market Development Committee will push pearlitic and will expand their over-all activities in connection with publicity. Regional sales clinics are scheduled for this fall and a 7th Annual Market Development Conference will be held next April.

The MFS gating and feeding studies will be continued, Liebau said. More work will be done by the Personnel and Plant Operations Committee in safety, human relations, and operating conditions, he indicated.

Congressman Walter H. Judd spoke on "The Trend of World Affairs" at the concluding session. Earlier sessions featured an evaluation of the MFS program, a report by James H. Lansing, technical and research director, and committee reports prepared by the following chairman: W. H. Moriarty, National Malleable & Steel Castings Co., Cleveland; George T. Boli, Northern Malleable Iron Co., St. Paul, Minn.; G. T. Behrendt, Eastern Malleable Iron Co.; W. J. MacNeill, Badger Malleable & Mfg. Co., South Milwaukee; W. S. Roby, Peoria Malleable Castings Co., Peoria, Ill.; W. H. Caldwell, Northern Malleable Iron Co.; W. A. Kennedy; H. E. Steinhoff, Wagner Malleable Iron Co., Decatur, Ill.; C. C. Chambers, Texas Foundries, Inc., Lufkin, Texas; S. E. Kelly, Eberhard Mfg. Co. Div., Eastern Malleable Iron Co., Cleveland; W. V. Osborne, Lakeside Malleable Castings Co., Racine, Wis.; and R. J. Anderson, Belle City Malleable Iron Co., Racine.

Officers and directors of the Malleable Founders' Society at the 1955 annual MFS meeting included seated (left to right): P. C. DeBruyne, President-Elect C. L. Liebau, Retiring President C. E. Brust, Vice-President-Elect Leon J. Wise, and Gardner Van Duyne. Standing are: R. E. Whinrey, C. P. Speitel, C. M. Brennan, Jr., W. H. Moriarty, R. L. Gilmore, George T. Boli, and Carl F. LaMarche.

obituaries

Herbert L. Edinger, 61, president, Barnett Foundry & Machine Co., Irvington, N.J., and a past president of the Gray Iron Founders' Society, died suddenly, June 26. Active in GIFS for many years, Mr. Edinger has been vice-president, a member of the Executive Committee, a director, chairman of the Cost Committee, chairman of the Technical Committee, received the advertising award in 1947 and the GIFS gold medal in 1954. He was a member of the Gray Iron Industry Advisory Committee to the Office of Price Administration during World War II and Office of Price Stablization during the Korean War. He was a past president and director of the New Jersey Foundrymen's Association. Mr. Edinger was associated with the Barnett Co. for 47 years, starting in 1908 when it was located in Newark.

Herbert L. Edinger

James H. Milliken, Chicago representative of the American Air Filter Co., passed away July 1.

William T. Koken, chairman of the board, Banner Iron Works, St. Louis, died June 21.

H. J. Sprecken, Sr., chairman of the board, Sturgis Foundry Corp., Sturgis, Mich., passed away recently. He was supervisor of all International Harvester Co. gray iron foundries until his retirement in 1948 when he organized and started Sturgis Foundry.

If you aren't a member of the American Foundrymen's Society you will want to subscribe to the new MODERN CASTINGS and American Foundryman. Simply fill out card at right and drop it in the mails.

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foundry trade news

American Radiator and Standard Sanitary Corp. has established an Atomic Energy Div. in Redwood City, Cal. Frank A. Parker has been appointed director of the new division and David J. Mallon, director of research operations.

Contenental Foundry & Machine Co., East Chicago, Ind., is constructing additions to present buildings at the company's Wheeling, W. Va., works. When completed, the machine shop will measure 68,594 sq. ft. and the erection floor will be enlarged to a total of 24,540 sq. ft. Also at Wheeling, Continental has integrated manufacturing with bar and tube equipment purchased recently from the Medard Co., St. Louis.

Durez Plastics & Chemicals, Inc., has been consolidated into **Hooker Electrochemical Co.** and will now operate as **Durez Plastics Div., Hooker Electrochemical Co.** Purchasing offices will be continued at North Towanda, N. Y.

Wheelco Instruments Div., Barber-Colman Co., have moved their Chicago office into new and expanded facilities at 6610 N. Sheridan Rd.

Ford Motor Co. has announced plans for major additions and alterations to its Cleveland engine plants and foundry. The project involves adding 300,000 sq. ft. of manufacturing floor space to engine plant No. 2's present 562,000 sq. ft., and expanding the production capacity of adjacent foundry by approximately 25 per cent. The engine plants and foundry are in Brookpark Village, a suburb southwest of Cleveland. A major realignment of production facilities and construction of 70,000 sq. ft. addition at the foundry is also planned. Ford is also negotiating with the Detroit, Toledo and Ironton Railroad to purchase 270 acres as a site for an engine plant north of Lima, Ohio, city limits. To contain about 950,000 sq. ft. of floor space, the plant is part of a $625,000,000 expansion and modernization program.

National Motor Castings Co., Div. Campbell, Wyant & Cannon Foundry Co., South Haven, Mich., has been awarded the highest honors for outstanding achievement in industrial safety. Award was made by Bernard J. Dillion, Michigan Mutual Liability Co. National Motor has maintained a no-lost-time accident prevention record for over two years.

Plans for the development of an unique $8,000,000 to $10,000,000 industrial park site, particularly suited to the needs of the metals industry, have been announced by *E. L. Baker,* the developer, and the **Industrial Department of the Fort Worth, Texas, Chamber of Commerce.** It will offer to industry a combination of out-of-city comforts and attractiveness and in-city conveniences for employees and industrial operations.

Philadelphia Bronze & Brass Corp., Philadelphia, has published a two-color booklet describing their foundry and forge facilities, shell molding facilities and quality control. Other information includes high conductivity copper; Mallory alloys for welding; aluminum bronzes, nickel alloys, and titanium alloys.

Stanley G. Flagg & Co., has moved its general and executive offices from 1421 Chestnut St., Philadelphia, to Three Penn Center Plaza, Philadelphia.

Compton Foundry, Compton, Calif., has published a circular covering Meehanite metal bar stock and a booklet illustrating and describing the operations of Compton Foundry.

Two new companies have been named to membership in the **American Foundrymen's Society** and three have converted from company to sustaining membership. New companies and their representatives are: **Milwaukee Shipbuilding Corp.,** Milwaukee, Donald W. Baumgartner: **B. F. Goodrich Chemical Co.,** Cleveland, L. L. Shailer, Jr. Conversions from company to sustaining include: **Republic Steel Corp.,** Cleveland, C. E. Hilkert; **Pittsburgh Crushed Steel Co.,** Pittsburgh, Pa., W. L. Kann; and **Canada Iron Foundries, Ltd.,** Montreal, Que., W. C. Perrot.

casting through the ages

Birdsboro Steel Foundry & Machine Co., Birdsboro, has started manufacture of a $2 million specialty merchant bar mill ordered by **Northeastern Steel Corp.,** for its plant in Bridgeport, Conn. Engineers of Birdsboro, manufacturers of steel mill machinery, are completing designs for the new mill after six months of study with Northeastern engineers and plant executives.

Continental Foundry & Machine Co., Chicago, has published a four-color booklet commemorating its 25th anniversary. Booklet illustrates and describes the company's various operations.

Expansion program by **Ohio Ferro-Alloys Corp.,** Canton, Ohio, is nearing completion with the starting of two new electric furnaces at the Philo, Ohio, plant. The furnaces are the largest yet built by the company and are housed in a new furnace building just completed. The new plant is actually a complete plant built near the original Philo plant. The large new electric furnaces will expand the plant's capacity by approximately 40 per cent.

For the second consecutive year **Union Carbide & Carbon Corp.,** New York, was presented the National Safety Council's Award of Honor on the basis of its 1954 safety record, which surpassed the corporation's all-time record set in 1953. During 1954, the accident frequency rate for corporation employees of 3.02 disabling injuries per million man-hours worked was 44 per cent below the par rate. The severity rate of 0.58 days lost per thousand labor hours worked was 38 per cent below.

Four companies recently have been elected to membership in the **Investment Casting Institute.** Companies and their representatives include: **Brace, Inc.,** Minneapolis, C. H. Brace; **Illinois Precise Casting Co.,** Chicago, Robert J. Harvey; **Industrial Fine Castings, Ltd.,** Toronto, T. W. Morewood; and **A. P. Green Fire Brick Co.,** Mexico, Mo., Karl K. Breit, elected as an affiliate member.

local foundry news

Southern California

Approximately 100 members and guests attended the Past Presidents' and Officers' Night meeting held in June at the Rodger Young Auditorium.

Charles Gregg, retiring president, introduced and thanked the various committee chairmen who served during his administration. He reviewed some of the highlights and accomplishments attained during the past year. He then presented the gavel to William C. Baud, incoming president.

Mr. Baud introduced the committee chairmen who had been selected to serve for the coming year. Four new directors who have been elected to serve the next two years were introduced.

Speaker of the evening was Dr. Jose (Tony Caboosh) Traigo, who kept the audience laughing with his humorous presentation.—*W. G. Stenberg.*

Washington

The Third Annual Ladies Night Dinner and Dance was held in June at the Elks Club, Bremerton, Wash. Mr. and Mrs. E. F. Riedle acted as co-chairmen and were assisted by Mr. and Mrs. Wessel and Mrs. Wolfer.

Leon Morel, Jr., chairman of the apprentice program, presented Albert Meier, Atlas Foundry & Machine Co., the second place award in the Steel Casting Div., of the AFS National Apprentice Contest, and Dave Sullivan, Pacific Car & Foundry Co., the third place award in the Wood Pattern Div. Mr. Morel outlined the planned activities in the apprentice program for next year.

Mr. Wessel introduced the new officers for the coming year. They were: *chairman,* Wm. A. Shaug, South Seattle Steel Foundry Co.; *vice-chairman* and *membership chairman,* Harold R. Wolfer, Puget Sound Naval Shipyard; *program chairman,* Wm. K. Gibb, Atlas Foundry & Machine Co., and *treasurer,* Vernon W. Rowe. Ballard Pattern & Brass Foundry.

Edward J. McAfee spoke on his attendance at the AFS National Convention in Houston, Texas, and said he thought the papers presented were the best to be given at any AFS Convention.—*Fred R. Young.*

Foundrymen's Fishing Derby

Fred Fulton, Maple Leaf Pattern Works, Ltd., Vancouver, B.C., has made arrangements for a Foundrymen's Fishing Derby for the British Columbia Chapter, to be held Saturday, August 27. Six or more prizes will be awarded to those catching the largest salmon and weighing in before 2:30 pm. Boats will be held until 6:30 am. Members from other chapters who happen to be in the Vancouver area are invited to attend. They should contact Mr. Fulton.

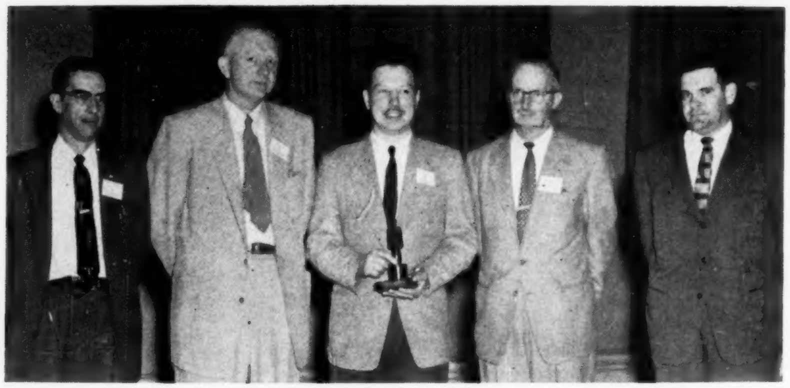
Last year the event attracted 125 fishermen and a larger number is expected to attend this year. Fish other than salmon will not be considered eligible for the prize awards.—*J. T. Hornby.*

Saginaw Valley

Student-Teacher Night featured talks by two Foundry Educational Foundation scholarship students from Michigan State College and a report on the activities of the Educational Committee.

O. Requadt, chairman of the committee, reported on the work

RON PREMO, METALLURGICAL ENGINEERS, INC.

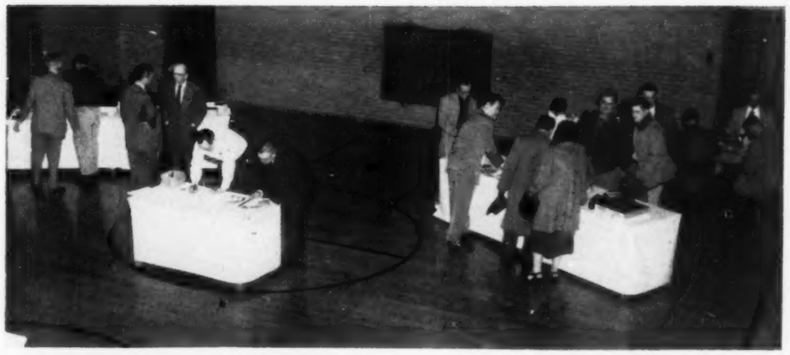


Oregon.. New officers and directors for 1955-1956, left to right: Norman E. Hall, Electric Steel Foundry Co., director; Fred Menzel, Rich Mfg. Co., program chairman; Harry Czyzewski, Metallurgical Engineers, Inc., chairman; Harry K. McAllister, Western Foundry Co., secretary-treasurer; and Robert M. Burns, Pacific Chain & Mfg. Co., director.

JACK HEYSEL, E. J. WOODISON CO.

Western New York.. Group attending the Spring Dinner Dance.

National Foundry Association.. Speakers table at the Birmingham Regional Meeting, from left to right: J. W. Brennan, R. N. Voight, both with U. S. Pipe & Foundry Co.; C. T. Sheehan, National Foundry Association; A. J. Fruchtl, U. S. Pipe; James Poole, guest speaker; Paul L. Arnold, U. S. Pipe; C. Hagler, Continental Gin Co.; B. Warren, American Cast Iron Pipe, and E. J. Warwick, Anderson Brass.



Northern Illinois-Southern Wisconsin—Judging the annual AFS Apprentice Contest is a public affair at Beloit Vocational and Adult School. Judges explain decisions and discuss entries with public and contestants in panel session after tallying results.

being done with the high schools and junior colleges in the Saginaw Valley area, to bring to the teachers and students an awareness of the foundry industry as a career.

As part of its work, the committee is preparing a booklet including the history of the foundry industry, its place in our national economy, job opportunities, a list of area foundries and foundry publications, recent advancements in the foundry, and what the design engineer expects from castings.

Professor C. C. Sigerfoos, Michigan State College introduced D. C. Freeman and C. J. Thomas, seniors at the college. Freeman discussed the various types of cleaning equipment available, and covered the advantages and disadvantages of each. Thomas discussed maintenance problems and touched briefly on costs.

Officers elected for the coming year were announced as follows: *chairman,* F. P. Strieter, Dow Chemical Co.; *vice-chairman,* J. E. Bowen, Chevrolet Gray Iron Foundry; *secretary,* V. J. Sadler, Jr., General Foundry & Mfg. Co.; and *treasurer,* F. A. Buike, Almont Mfg. Co.

Directors elected were: D. J. Christensen, J. R. Ikner, T. R. Wiltse, and H. V. Grieve.—*N. Sheptak.*

Michigan State

Newly elected officers for the Michigan State Student Chapter are: *chairman,* Jack C. Lane; *vice-chairman,* Ronald N. Friedman; *secretary-treasurer,* Jack S. Macauley, and *corresponding secretary,* Rennie Swope.—*C. C. Sigerfoos.*

How to Pick a Winner

Judges are really put on the spot under the procedure used at the annual Patternmakers' and Molders' Apprenticeship Contest at Beloit Vocational and Adult School. The contest is sponsored by the Northern Illinois-Southern Wisconsin Chapter of the American Foundrymen's Society as part of the Society's national competition.

Judging procedure makes the contest unusual. The judges are in-

Penn State.. Members of the student chapter and their advisors.

KEN SCHECKLER,

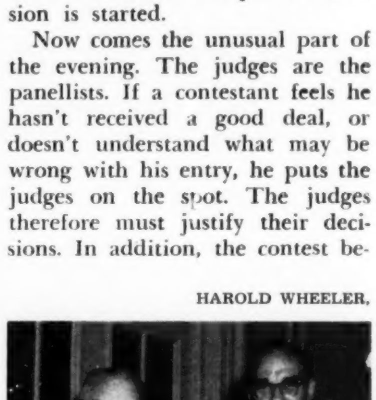
Southern California .. Hubert Chappie, National Supply Co., and past president of the chapter, congratulating retiring president, Charlie Gregg, Gregg Iron Foundry, for his spendid work.

vited to a dinner at the school. All concerned become acquainted and are briefed. Judging begins about 7 p.m. The entries are displayed on white skirted tables in the gymnasium. During judging the public is not allowed on the floor but can watch from the bleachers.

When the judges have finished, and while tallies are being made, the public is able to view the students' work at first hand. Upon completion of the tally the winners are announced and a panel discussion is started.

Now comes the unusual part of the evening. The judges are the panellists. If a contestant feels he hasn't received a good deal, or doesn't understand what may be wrong with his entry, he puts the judges on the spot. The judges therefore must justify their decisions. In addition, the contest be-

HAROLD WHEELER,



Northeastern Ohio .. S. E. Kelley, Eberhard Mfg. Div., Eastern Malleable Iron Co., left, presenting retiring chairman David Clark, Jr., Forest City Foundries Co., with plaque for work as chairman for past year.

Quad City—L. E. Wass, Davenport Public Schools (left), presents memento of Tall Corn State to Dr. Ralph L. Lee after speech.

comes a significant learning situation. The winning patterns and castings and the losing patterns and castings are thoroughly discussed point by point. Such a session often lasts three hours, with public interest remaining until the end.

In this year's competition, William Ryerson, Gilford Pattern Works, Rockford, won first in wood patternmaking; John Nelson, McGue Pattern Works, Rockford, was second, and Jack Stewart, Fairbanks, Morse & Co., Beloit, was third. Metal patternmaking winners were Fred Whittemore, Fairbanks, Morse & Co., first; Harold Bates, Fairbanks, Morse & Co., second. Molding division winners, all from Fairbanks, Morse & Co., were James Sanders, first, Roger Rufer, second, and Eugene Mahan, third.

Quad City Runs a Dinner

The Quad City Chapter of AFS turned out 80 members strong in support of the 13th Annual Industrial Education Dinner sponsored by the Industrial Educational Department of the Davenport Public Schools. Total attendance was about 250 persons.

The annual vocational dinner is supported by various industries but this year the foundrymen for the first time in any industry, assumed total responsibility for programming the affair. Organization was handled by William T. Ellison, Thiem Products, Inc., chapter chairman; Edward F. Peterson, Martin Engineering Co., chapter educational chairman; and L. E.

E. H. MOSSNER

Saginaw Valley .. New officers elected for the coming year, from left to right: F. P. Strieter, Dow Chemical Co., chairman; J. E. Bowen, Chevrolet Gray Iron Foundry; vice-chairman; and V. J. Sadler, Jr., General Foundry & Mfg. Co., secretary.

Wass, head of the school's industrial engineering department.

Main speaker was Dr. Ralph L. Lee who spoke on *"Leadership and the Qualities a Good Leader Must Possess."* Brief talks were also made by Chapter Chairman Ellison, and Ashley B. Sinnett, AFS educational director.—*John G. Smillie.*

Birmingham Goes to Class

More than 100 employees of Birmingham, Ala., foundries attended a series of four advanced educational sessions sponsored by the Birmingham District Chapter of the American Foundrymen's Society in the spring. Attendance ran as high as 107 at the four sessions which covered advanced molding methods, melting methods, casting methods and cleaning and finishing methods. A certificate was presented to all those attending three or more sessions and a foundry text-book to those attending all four sessions.

The Birmingham Chapter's educational steering committee is made up of C. K. Donoho, American Cast Iron Pipe Co., chairman; T. H. Benners, T. H. Benners & Co.; M. D. Neptune, National Cast Iron Pipe Co.; and Aubrey H. White, Stockham Valves & Fittings Co. The committee has also developed an educational program to acquaint high school students with the foundry industry. Motion pictures are shown, and a subscription to MODERN CASTINGS is given to interested high schools. All high schools are informed in detail of the Birmingham Chapter's program.

NORMAN E. HALL, ELECTRIC STEEL FOUNDRY CO.

Oregon State . . New officers of the Oregon State College Student Chapter, from left to right: Herb Singleton, treasurer; G. Palmer Byrkit, vice-president; B. Banks, president, and S. Rabe, secretary.

National Foundry Association

Regional meetings of the National Foundry Association were held in Chattanooga, Tenn., and Birmingham, Ala., recently.

Paul L. Arnold, U. S. Pipe & Foundry Co., and national vice-president of NFA, acted as chairman of the Chattanooga meeting. A. J. Fruchtl, U. S. Pipe & Foundry Co., was chairman of the Birmingham meeting.

Featured speaker was James I. Poole, labor attorney with Fairchild, Foley & Sammond, Milwaukee, and his subject was *"Critical or Crisis Bargaining."* He outlined the various approaches to collective bargaining which are used by some of the leading foundries.

Emphasis was placed on steps which could be taken in preparation for negotiations which would serve to reduce friction and act as protective measures in preventing industrial strife. Mr. Poole stressed the need for year-round preparation instead of last minute gathering of facts; the necessity of constantly watching those areas of an agreement which were not functioning properly and jotting down suggested changes which could be used as company proposals when negotiation time rolls around instead of trusting to memory. The importance of adequate employee communications was discussed in great detail.—*C. T. Sheehan.*

Penn State

New officers elected for the Penn State Student Chapter for the coming year are: *chairman*, Kenneth E. Reisch; *vice-chairman*, Larry Redmond; *recording secretary*, Harry Nelson; *corresponding secretary*, Nick Kralles, and *treasurer*, Frank Todd.

Twin City Runs Safety Contest

In the first four months of the pioneering safety contest sponsored by the Twin City Chapter of the American Foundrymen's Society, the 20 foundries in the contest had had only 14 lost time accidents with a total of 89 lost time days out of 952,910 man hours of exposure.

The number of lost time days gave the group an accumulative severity rate of 0.094—compared with an average severity rate of 1.05 for the foundry industry as a whole in 1954. At the end of five months nine of the foundries had yet to have a lost time accident.

The Twin City contest was started on November 1, 1954, to run a full year. At the end of the year an award will be made to the foundry or foundries with the best record. A few definite rules have been established, such as definition of a lost time accident, and agreement to measure results based on hours of exposure.

The contest is being run by the Safety Committee of the Twin City Chapter, of which Carter De Laittre, Minneapolis Electric Steel Castings Co., is chairman. Also active have been A. W. Johnson, Northern Malleable Iron Co., and Wayne Carlson of American Hoist & Derrick.

Reports are made out for each foundry in the contest and are presented at each monthly chapter meeting. All members attending the chapter meetings receive a copy. The monthly standings in the contest are tabulated and each member also receives a copy of the tabulations.

The accumulative frequency rate for the Twin City foundries in the contest was 14.7 for the first four months of the competition which compares with 10.94 for foundries which are members of the National Safety Council and 20.7 for the U.S. as a whole.

The frequency rate for any period is figured on the basis that

$$\text{Frequency} = \frac{\text{No. lost time accidents} \times 1{,}000{,}000}{\text{Total hours of exposure}}$$

The severity rate is figured on the basis that—

$$\text{Severity} = \frac{\text{No. lost time days} \times 1000}{\text{Total hours of exposure}}$$

The Twin City Chapter contest is one of many influences which are working to improve foundry safety. In the past five years the foundry accident frequency rate has been falling consistently and the industry is now approaching a point where it is competing with other industries in safety records and programs.

The Bureau of Labor Statistics points out that in the logging industry there were 73.2 disabling injuries for each million hours worked during 1954; in sawmills and planing mills, 42.2; and in the manufacture of structural clay products 40.5. There were seven industries with rates between 25 and 30; 14 with rates between 20 and 25; and 22 with rates between 15 and 20. The foundry frequency rate in 1954 was 20.7

Movie Shows Preferred Vertical Gating System

Color motion picture dealing with the fluid flow of molten alloys through vertical gating systems has just been completed by the American Foundrymen's Society, under the direction of the Research Committee of the Light Metals Div., with the cooperation of Frankford Arsenal.

Battelle Memorial Institute has, under AFS sponsorship, been developing a design for an improved vertical gating system. Conducted by studying the flow characteristics of water poured into transparent plastic models of various gating systems, the investigation continues the work on gating reported in three other AFS films.

The latest 16mm sound film is approximately 1600 ft. long and runs about 40 min. To arrange a showing, write to American Foundrymen's Society, Golf & Wolf Rds., Des Plaines, Ill., Attn.: Hans J. Heine, Technical Director, giving alternate dates. Rental on the film is $20.

chapter meetings

AUGUST

6 . . Chicago
Lincolnshire Country Club, Crete, Ill. Annual Stag Outing and Golf Party.

13 . . Southern California
Lakewood Country Club, Long Beach. Annual Picnic.

SEPTEMBER

10 . . Tennessee
Camp Columbus, Chattanooga, Annual Barbecue.

18 . . Michiana
Tabor Farms, Sodus, Mich. Annual Picnic.

classified advertising

For Sale, Help Wanted, Personals, Engineering Sevice, etc.,

set solid . . 20c per word, 30 words ($6.00) minimum, prepaid.

Positions Wanted

. . 10c per word, 30 words ($3.00) minimum, prepaid. Box number, care of **Modern Castings**, counts as 10 additional words.

Display Classified

. . Based on per-column width, per inch . . 1-time, $15.00; 3-time, $13.50 per insertion; 6-time, $12.50 per insertion; 12-time, $12.00 per insertion; prepaid.

HELP WANTED

AGENTS. To sell replacement wear parts for Sandslingers, parts to fit "Wheelabrator" Shot Blast Equipment, and for similar wear applications. Product group is already established and accepted. Need agents familiar with foundry and metal cleaning industry. Attractive commission arrangement. No inventory. Openings in South and Mid-West. **LATROBE STEEL CO., Special Products Div., Latrobe, Pa.**

PRODUCT MANAGER. Person to handle sales program, set up and assist jobbers, and develop a direct mail and advertising program. Product group includes fine quality replacement wear parts for Shot Blast Equipment, Sandslingers, and other such foundry or metal cleaning equipment. Position involves traveling. Person must be aggressive and proven in sales ability. Desired age 25-40. Write full details to **Box C45, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.** Include a recent photograph.

TIME STUDY MAN. Experienced in foundry study. State salary required and full qualifications. **Box C49, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

RESEARCH ASSISTANTSHIP. Starting September 1, 1955, at $130.00 per month plus out-of-state tuition exemption. Holder takes full course in Graduate School leading to an M. S. degree, using research on ferrous foundry metallurgy for Master's thesis. Address **Professor R. W. Heine, Dept. of Mining and Metallurgy, University of Wisconsin, Madison 6, Wis.**

GENERAL FOREMAN. Established manufacturer, Piedmont, South Carolina needs general foreman for expanding foundry division. Age 35 or younger. College degree preferred. Thorough knowledge of cupola operations required. Must have wide foundry experience including gating, sand and molding in diversified small and medium jobbing and production. Salary open.
BOX C50, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.

Form Joint Welding Group

The American Welding Society and the American Foundrymen's Society recently inaugurated an organization known as the AFS-AWS Joint Committee on Welding Iron Castings.

This committee is concerned with the welding of castings of gray iron, malleable iron, and nodular iron in the course of fabrication, reclamation, or repair. All aspects of welding, including selection of filler metal, welding procedures, welding techniques, postweld heat treatments, testing, inspection, and quality control are to be investigated. The committee will cooperate in the preparation or revision of specifications or other standards issued by other organizations or committees dealing with iron castings.

AFS members include: J. S. Vanick, International Nickel Co., Inc., New York, temporary chairman; William J. Bueche, Atlas Foundry Co., Cleveland, also represents Gray Iron Founders' Society; C. H. Burgston, Deere & Co., Moline, Ill.; George Dinges, Nordberg Mfg. Co., Milwaukee; Thomas E. Eagan, Cooper-Bessmer Corp., Grove City, Pa., also represents A.S.T.M. Committee A-3; Walter W. Edens, Allis-Chalmers Mfg. Co., Milwaukee; S. E. Kelly, Eberhard Mfg. Co., Div. of Eastern Malleable Iron Co., Cleveland, also represents Malleable Founders' Society; James H. Lansing, Malleable Founders' Society, Cleveland, also represents A.S.T.M. Committee A-7.

E. S. Lawrence, Schenectady Foundries, General Electric Co., Schenectady, N. Y.; George A. Meyer, Jr., Malleable Founders' Society, Cleveland, also represents Malleable Founders' Society; B. F. Shepherd, Ingersoll-Rand Co., Phillipsburg, N. J.; R. F. Sherwin, Chicago Hardware Foundry Co., North Chicago, Ill., also represents Gray Iron Founders' Society; Warren M. Spear, Worthington Corp., Harrison, N. J., alternate, Russell J. Allen, Worthington Corp., Harrison, N. J.; M. L. Steinbuch, Lunkenheimer Co., Cincinnati; Herbert W. Stuart, U. S. Pipe & Foundry Co., Burlington, N. J., also represents A.S.T.M. Committee A-3; and Charles F. Walton, Gray Iron Founders' Society, Cleveland, also represents Gray Iron Founders' Society.

A.W.S. members include: J. E. Fitzwater, International Harvester Co., Chicago; H. V. Inskeep, Linde Air Products Co., Newark, N. J.; Sidney Low, Chapman Valve Mfg. Co., Indian Orchard, Mass., also represents Manufacturers Standardization Society of the Valve & Fittings Industry; Bela Ronay, U. S. Naval Engineering Experiment Station, Annapolis, Md.; S. T. Walter, Air Reduction Sales Co., New York; and S. A. Greenberg, American Welding Society, New York.

Welding of non-ferrous and steel castings was considered at the time the joint committee was formulated. It was recommended, however, that separate committees covering these materials be organized after the committee on welding iron castings was functioning.

Issue Foundry Information Book

Mass ignorance of the layman regarding castings and the industry that produces them has prompted release of a revision of THE FOUNDRY IS A GOOD PLACE TO WORK. Recently reissued by the American Foundrymen's Society, the colorful, highly illustrated, 24-page booklet was written for students (grades 8-12) and their parents, as well as laymen with little or no knowledge of the castings industry. In addition to its use for general informational purposes, the booklet is expected to help students in choosing a career by indicating job opportunities available to them. To assist in this, copies are being sent to occupational information instructors and guidance counselors by the AFS Education Dept. The booklet will also be distributed through Chapter Educational Committees of the Society.

Foundries utilize many skills, THE FOUNDRY IS A GOOD PLACE TO WORK points out in naming some of the many types of production workers used in the five basic foundry departments: molding, coremaking, melting, cleaning, and control. Emphasizing that every product begins in the foundry, the booklet explains why the shortest distance between raw materials and finished products is a casting. Also covered are the operations involved in castings production, the non-production types of jobs open in the business phases of the foundry, and the ways in which foundries train their men.

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FOR MO

New NBS Standard Samples

Spectrographic standard samples of six high-speed tool steels now available from the National Bureau of Standards are complex alloys of iron, chromium, vanadium, molybdenum, tungsten, and cobalt, together with small amounts of other elements.

Samples of 7/32-in. rod, 4 in. long and ½-in. rod, 2 in. long are centerless ground to serve as electrodes for spark excitation.

Standards may be obtained from the Bureau for $8 each.

Spectrographic Method

Details of a universal spectrographic method for determining ten common constituents of iron and steel (not depending on sample size) have been reported by the Spectrographic Laboratory at Picatinny Arsenal. Spectrographic conditions and experimental procedure for determining silicon, manganese, nickel, chromium, cobalt, molybdenum, titanium, niobium, vanadium, and aluminum are described. Results are shown in numerous tables and logarithmic graphs. The 72-page publication Code No. PB 115587, on microfilm $3.75; photocopy $10.25, is available from Library of Congress, Publication Board Project, Washington 25, D. C.

Fork Lift Film Released

A new 15-min color film, showing on-the-job applications of the TerraTrac crawler-mounted M-3 fork lift has been released by American Tractor Corp. The movie includes action shots of the new lift extension for carrying and placing loads to heights of 21 ft.

Also illustrated is the quick convertibility of the machine for bulldozing and handling bulk materials and the ease and speed of moving job-to-job with the new TerraTrac tilt trailer. Arrangement for viewing the film can be made by contacting local TerraTrac distributors and dealers, or by writing American Tractor Corp., Churubusco (Ft. Wayne), Ind.

FOR MORE FACTS, CIRCLE No. 89 P. 81-82

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